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ELECTRO-MOTORS.

FOR many years past the electro-motor has been a very fascinating subject to inventors, and much ingenuity in design and skill in mechanical construction have resulted from their labours.

The earlier workers in this domain, however, had generally a very mistaken or highly exaggerated idea of what could be accomplished in this direction, and it is only now beginning to be understood that an electro-motor is a very ordinary machine after all. We have at the present time a number of more or less effective motors, but the demand for them is not anything like that which the importance of these highly-useful apparatus should command. So far as small motors, such as may be used for dental purposes, sewing machine driving, &c., are concerned, we believe that a serious drawback to their more extended employment is the want of a battery which shall require no attention for a moderate period. It would be somewhat difficult to imagine a more disagreeable task than that of constantly keeping a battery in working order, and one quickly gets disgusted with the ever-recurring and monotonous labour therein involved. Without doubt, the sale of many electrical articles of household use is very soon diminished, if not entirely stopped, by the failure of the battery connected therewith. We could point to an exceedingly ingenious electrical gas-lighter which was brought out some two years ago and many thousands of which were disposed of, but the apparatus turned out a failure because the battery could not be depended upon for any length of time.

But we think that a considerable field for the employment of inventive genius is open to those who will turn their attention to electro-motors for doing heavy duty, and which, being worked from dynamos, will be free from the troubles caused by unreliable batteries. We can only call to mind one or two inventors whose motors are at all suitable for such work as, for instance, Professor Jenkin's system of telpherage, electrical trams, &c. Of course we do not speak of dynamo-electric machines proper, which may be used as motors.

We may naturally expect electrically worked tram-lines, such as that so successfully established by Mr. Volk at Brighton, and also that now being arranged on Ryde Pier, to increase and multiply as the years roll on. It is also probable that we shall shortly see short lines of electrical railways, such as that of Danchell's, in operation, and the demand for electro-motors of the highest efficiency will soon become pressing. The question will then be, who is to supply them?

TESTING LIGHTNING CONDUCTORS.

MESSRS. SIEMENS BROS. & CO., Limited, have recently manufactured a portable and handy instrument for testing lightning conductors and earths, the device of Mr. E. O. Walker, of the Indian Telegraph Department. It consists of a small magneto-inductor enclosed in a wooden case, turned by a handle outside, and so arranged as to give a continuous current in one direction. A simple galvanoscope, wound with two turns of bare thick copper wire, graduated so as to indicate the resistance in circuit when the magneto-inductor is maintained at the highest speed by hand, is placed about three feet from the box, so as not to be disturbed by the magnets. A connection is made to the top of the conductor, and the circuit completed through a second temporary earth. If the resistance indicated by the galvanoscope as in circuit be small, then the conductor may be considered electrically satisfactory. If, on the other hand, says Mr. Walker, the conductor or its earth, or the temporary earth, should be of high resistance, then a third earth would be employed in the usual way, and the following equations obtained :—

x—Lightning conductor and earth.
y—1st temporary earth.
z—2nd temporary earth.

Then

$$x + y \begin{cases} \text{R.} & \text{L.} \\ a. & b. \text{ when + pole of instrument to } x, \\ c. & d. \text{ when + pole of instrument to } y, \end{cases}$$

and the mean of the four resistances, a, b, c, d, taken as the true one. Similarly with $x + z$, and $y + z$, from which three equations of course x, y, and z, can be found. The box is furnished with a pouch at the side to contain the galvanoscope, and handle of the inductor when not in use, and a brass handle on the top serves to carry the apparatus easily from place to place.

It is well suited for tests by persons unskilled in electrical measurements, and will enable tests to be rapidly executed.

The apparatus is also made in the "Bridge" form, in which the needle is brought to zero by moving a handle round a dial furnished with resistances. In this case the results are actually free from errors arising from inconstancy of speed of the magneto-inductor, which really takes the place of the galvanic battery usually employed.

ON THE USE OF DYNAMO-ELECTRIC MACHINES AS A SUBSTITUTE FOR TELEGRAPHIC BATTERIES.

By M. ROTHEN.

(*Continued from page* 125.)

THIS way, however, has been pursued in subsequent experiments made by electricians in other countries. Thus, the Western Union Telegraph Company in America has established dynamos to serve the lines of its central office in New York. The dynamo does not act directly on the lines, but its current passes through different inductors, varied according to the resistance of the lines, so that each receives a current suitable to its condition. Similar trials have been made by M. Kohlfürst, of Prague, but the most important experiments have taken place lately at the central telegraph station of Berlin. The current is supplied by a dynamo with a non-reversible current, primed by another small machine. In December, 1883, they worked at once on a number of lines, varying from 14 to 18. In the month of January following the application of this method of telegraphy was extended to 40 lines, 12 of which were subterranean, 2 aerial served by the Hughes apparatus, whilst 11 subterranean and 12 aerial lines were served by the Morse apparatus, and 3 lines

with continuous currents. A curious feature of this experiment is that the difference of potential at the two extremities was only 40 volts, whilst the batteries commonly employed amounted to 80 elements, and consequently presented a double electromotive force. The service with the dynamo was nevertheless effected perfectly, although the force of the current varied much from one line to another on account of the great differences of resistance.

As with batteries they succeeded in establishing transferences, and it was even believed that the action of the Morse manipulator was susceptible of a little acceleration on long wires. The service of the continuous current was effected equally well whether the batteries were allowed to remain at the other extremities of the line, or the dynamo alone furnished the current. All these facts prove that the quantity of electricity yielded by the machine was more than sufficient to supply the 40 lines. It remains to be explained how the machine has been able to give such good results in spite of the inferiority of its electromotive force as compared with the batteries in common use. This explanation must, I believe, be sought in the nature of the currents furnished by the dynamo machines. Though it is impossible to observe the rhythmic variations of the force of the current by means of a galvanometer, these variations still exist, and may be discovered easily by introducing a telephone in the derived circuit of one of these machines. The mean difference of potential at the extremities of the machine is composed, therefore, of differences larger and smaller than this mean, which succeed each other with great rapidity, and which can be determined by the height of the sound heard in the telephone. May it not hence be admissible that the electric shocks emanating from the dynamo set the armatures of the apparatus in a commencement of movement which a much feebler current is then able to keep up?

In installations of the electric light it is customary to introduce a short piece of lead to protect the conducting wires which enter the houses against the influences of too strong currents. Something analogous has been done at Berlin with the telegraph wires by introducing into the circuit short thin steel wires, enclosed in porcelain tubes, and which burn before too strong a current can enter the line.

It is to be desired that these trials with dynamos should be still continued, for it is almost impossible to find immediately the best solution of this new problem in telegraphy. The application of dynamos presents, in fact, certain difficulties, of which the following are the most serious :—

1. The external resistance is so great that the machine does not prime.
2. The different lines of large offices have very different resistances.
3. The work which the dynamo has to furnish must vary appreciably according to the different hours of day and night, and such variations may occur even from moment to moment.

We will examine each of these difficulties in succession :—

1. *Magnitude of the External Resistance.*

In an article on the progress of the electric light (*Journal Telegraphique*, Vol. VIII., p. 26) we have already pointed out that for every dynamo machine there exists an external resistance at which it ceases to prime, and, in fact, the majority of telegraphic lines present such great resistances that they exceed the limit at which the machine primes. There are three means of surmounting this difficulty. The first, employed by Schwendler, consists in establishing along with the telegraphic circuit, another with a very low external resistance. But this means can only be employed when there is for the principal quantity of electricity produced a utilisation independent of the service of transmission, and being equally continuous with the work of the telegraphic offices. It may, for instance, by day furnish the current for a galvanoplastic establishment, or maintain the mechanical movements of the Hughes or Morse apparatus, or work a crane at a yard or wharf. M. Schwendler sought for such a utilisation in heating the offices by means of great coils of nickel-silver wire. But this last application of electric energy appears to us, for the present, at least, of doubtful practicability, and in all cases it would have the defect of being applicable only in cold weather. As for the different transmissions of force it must not be forgotten that the direct application of the primitive motive power of a dynamo will always be more advantageous, except in the case where the source of the power is at so great distance from the telegraphic office that it can only be transmitted by electric procedures. The cases where Schwendler's method could be advantageously used are, therefore, very rare, so that the application of dynamo machines will be appreciably increased only when they are to be met with everywhere, and when the small fraction of force necessary for working the telegraph can be hired from some adjacent workshop.

A second means is that used in the Berlin expeririments. By exciting the electro-magnets with an accessory machine we obtain a difference of potential at the extremities of the wire of the armature even if the external resistance is infinite; the current is therefore produced in every circuit, independent of its resistance. This solution seems to us one of the best for overcoming the difficulty which we are here examining.

The third procedure is the use of a magneto-electric machine. The effect is the same as in the foregoing case. A machine suitable for this purpose is that of de Meritens with a continuous, non-reversible current. In this machine four strong magnets excite the ring, composed of 64 coils, the 64 wires of which converge to a collector with 64 blades. It furnishes two independent currents.

This might be the proper place to examine those systems which depend on the introduction of some intermediate organ between the machine and the telegraph wires, for instance, the induction bobbins which we have recently seen in use at the central office in New York, or else accumulators. But an examination of utility of the introduction of such introductions will be more appropriate when we come to treat of the utilisation of the excess of electricity produced by the dynamo, or of the stoppage of the machines during the night.

2. *Differences of Resistance between the Lines of an Office.*

The Berlin experiments prove that the dynamo bears great differences of resistance better than the battery. This results from the fact that a certain number of lines have been served by the same dynamo without injury to the service. But in this experiment the conditions were not normal. The dynamo furnished much more electricity than was necessary, so that even the longest lines received sufficient for the working of the apparatus. In a regular service we could not reckon on this overplus of electricity, and varying differences of potential will therefore occur. Four different electromotive forces, of respectively 25, 50, 75 and 100 volts seem sufficient for all the wants of a great telegraphic office.

In this case we should have four different dynamos, which should, besides, have a very low internal resistance or be constructed on the "compound" system, so that the current may not change when the number of circuits varies. If we suppose the internal resistance of the dynamo very feeble, *e.g.*, of a few ohms, it will become impossible to remark the variations of the current in a line, when the number of the other lines of the same resistance through which the current passes varies simultaneously.

A simple means which enables the number of dynamos to be reduced to one, is to equalise the resistances of all the lines of the office by means of auxiliary resistances. We thus, doubtless, increase the useless work of heating the current of the line, but the

total work is so small that a slight increase is of little importance. Suppose that in the office there are 50 wires to be supplied, the longest of which has a resistance of 6,000 ohms, and that the auxiliary resistances to obtain this maximum resistance in each wire give a total of 50,000 ohms; the increase of useless work will be only one-fifth. If we adopt for each line a current of 10 milliampères, a total current will be required of 0·5 ampère, whence $0{\cdot}5 = \frac{x}{120}$, *i.e.*, the difference of potential at the extremities of the machine should be 60 volts and the effective work 30 volt-ampères, or about $\frac{1}{25}$ horse power. It has, however, been proposed to utilise the work produced in the auxiliary resistances, which would be otherwise lost, by placing these resistances upon the electro-magnets of the dynamos themselves, where they will play the part of a compound coiling. A similar complication seems to us an inconvenience greater than the advantages resulting from this utilisation.

The small electro-magnetic machines which are at present in general use for signalling in electro-magnetic systems, gave us the idea of applying them in telegraphy. The ordinary apparatus, having an internal resistance of 500 ohms, easily develop an electromotive force of 45 volts. The system must, of course, be changed so that instead of alternating currents the machine may yield currents having always the same direction. If we stop, as above, at a current of 10 milliampères for the circuits, we have

$$0{\cdot}01 = \frac{45}{500 + x}$$

whence it results that the external resistance for ordinary machines may go up to 4,000 ohms. We may thus serve a direct line, constructed of wire of 5 millimetres in thickness and 500 kilometres in length, at the end of which is an apparatus of 500 ohms of resistance, or an omnibus line of 3 millimetres having, for instance, 5 intermediate offices and a total length of 50 kilometres. For longer direct lines, or for omnibus lines having a greater number of intermediate offices, more powerful machines are required. It is the same for lines worked with apparatus demanding a stronger current, such as that of Hughes or Baudot. We should have then a series of magneto-electric machines of different sizes, but all relatively small and requiring a very feeble motive power, furnished by a water or a gas machine, and all put in motion by pullies. If one or other of the lines remains inactive for a certain time, as is the case for a great number of lines during the night and for lines supplying offices where the service is limited to certain hours of the day, the corresponding machine may be stopped. We may even place these little machines so close to the apparatus that the telegraphists can set them in motion or stop them without leaving their seats.

3. *Great Variations of Force necessary during different Hours of Day and Night.*

Here is a difficulty which is felt also in the other applications of electricity for light, for the transmission of force, &c., and it often becomes an obstacle to the use of electric procedures on account of the expense resulting. In the dynamo with the "compound" system of coiling, the yield of electricity varies according to the external resistance, and in this respect the problem is solved; but we have also to take into account the variation of the motive power. If this power is furnished by a turbine which receives water *ad libitum*, the consequences are not very serious; but the cases are probably very rare where the installation can be placed in such advantageous circumstances. Almost invariably, on the contrary, we have to have recourse to gas or steam engines. The gas engine is less limited in its yield of power than the steam engine. It is therefore to be recommended as motor for large telegraphic offices, but with it also the extreme quantities of motive power required are too different to permit of the same motor being used during the chief business hours of the day and during the hours of the night.

To pass from a large machine to a small one is not a very suitable solution of the problem. There remains, then, only one of these two alternatives: either to employ the motive power for executing also other work in addition to the generation of electricity for the currents, or to make use of accumulators which enable the dynamos to be stopped during the night.

For the multiple utilisation of the motive power the electric light first occurs, for it is precisely in the hours when the telegraphic service slackens that the need for artificial light appears. In proportion, then, as the electricity becomes available, it may be applied for lighting up the working rooms. Yet the point of time when the lights will be best supplied will fall between midnight and 4 a.m.; *i.e.*, in that part of the night when the telegraphic service is almost dead. This solution, therefore, is incomplete. It has been also proposed to utilise the available motive power for moving the Morse, Hughes, &c., apparatus, or for effecting the mechanical transmission of apparatus from one office to another; but the maximum of force consumed in this manner coincides exactly with the same hours of the day which demand the maximum of the current. In our opinion this, also, is a solution to be rejected. We see how difficult it is to find a proper use for the disposable force, the quantity of which augments in proportion as the demand for electricity diminishes. It will be best to stop the machines during the night.

To this end it will be necessary, during the day, to charge accumulators, and to make use of them for night work. All the inventions, all the studies made hitherto relative to accumulators show that we have not yet overcome the great difficulties presented by this apparatus for storing up electricity. But, on the other hand, it must be recognised as a maximum of work, *i.e.*, to furnish a relatively strong current for the electric light.

In the use of accumulators in telegraphy the conditions are quite different, because there, for instance, the external resistances are relatively great. Suppose that during the night 5 lines, each of 5,000 ohms, are at once in action, the external resistance will then be 1,000 ohms, and as the electromotive force of each element may be taken at 2 volts, there will be required 25 secondary elements to give in each line a current of 10 milliampères.

When they are required to furnish currents so feeble only, the accumulators become exhausted slowly; the difference of potential will remain almost the same during the whole night. The low internal resistance of these accumulators offers another advantage, for the internal resistance being practically nil, the current will not change its force when other lines are switched on or shut off.

The charge of the accumulators may be effected in different manners.

The simplest method seems to be to charge them in the evening when the service has already considerably slackened, and when the motor no longer requires to turn with full force. Whilst charging the accumulators we continue to work the lines with the dynamo, and the surplus of electricity will flow into the accumulators. When these are charged the motor is stopped, and the accumulators are brought into play.

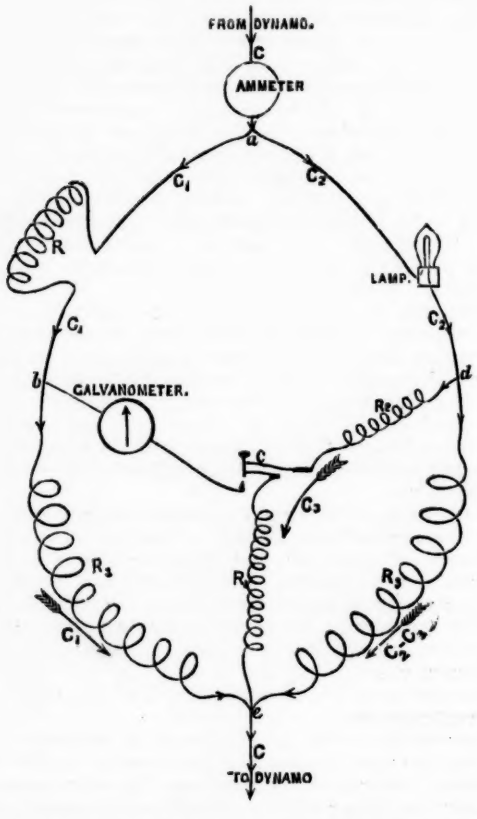
Another system consists in charging the accumulators during the day. All the current of the dynamo would pass into the accumulators if no manipulator reduced it, and in proportion as the lines are served by the current the quantity passing into the accumulators will diminish, or become nil, when all the instruments are in use simultaneously. In this manner the accumulators are charged continuously, but a more complicated form must be given to the manipulators. Practice alone can show which of these two systems is the most advantageous. This is a further reason why we desire to see experiments on the use of dynamos in telegraphy pursued further.—*Journal Telegraphique.*

EXPERIMENTS ON THE EFFICIENCY OF INCANDESCENT ELECTRIC LAMPS.

IN the ELECTRICAL REVIEW for July 19th we published the results of some experiments on incandescent electric lamps made by Mr. Horace B. Gale, of the Massachusetts Institute of Technology. Further information relating to these tests appears in the last number of *Van Nostrand's Engineering Magazine*, and we now reproduce the chief items of interest:—

There were two simultaneous measurements of current to be made. As there was, however, but one reliable ammeter at the writer's disposal, an arrangement was devised by means of which the strength of two electric currents—for example, the current through the lamp and the current through a resistance coil in derivation with the lamp—could be compared with each other by means of the Wheatstone bridge.

As this method is the most accurate one known to the writer for comparing strong currents of electricity, and as it requires no special apparatus except an ordinary Wheatstone bridge, it will be described in full, in the hope that other experimenters may find it useful. The arrangement will be understood from the accompanying diagram.



The current, C, from the dynamo passes through the ammeter, and divides at the point, *a*, between the two branches, *a b e* and *a d e*, of the circuit, one portion of the current whose strength is denoted by C_1, passing through the resistance coil, R, and the other, C_2, passing through the lamp, which stands in its place at the end of the photometer bar. *b e* and *d e* are two coils of heavy copper wire of small resistance, but exactly equal to each other; the resistance of each being denoted by R_3. After traversing these coils the currents, C_1 and C_2, unite at *e*, and return to the dynamo. *d c* and *c e* are two arms of the Wheatstone bridge whose resistances are marked R_2 and R_1. The bridge proper, containing the galvanometer, is from *b* to *c*, the circuit through it and the resistance coils, R_2 and R_1, being closed in the ordinary manner by a double key, at *c*. When the key is closed, a small portion of the current, C_2, is shunted around *d e* through the coils, R_2 and R_1, of the bridge. This current is denoted by C_3. Then the current passing through the portion, *d e*, of the circuit is $C_2 - C_3$, as indicated in the diagram.

In using the apparatus, the arm, R_1, is made a certain fixed resistance, say 1,000 ohms. The resistance, R_2, is then adjusted, until, on pressing down the key, no current passes through the galvanometer. The points, *b* and *c*, are then at the same potential. It follows that the difference of potential from *b* to *e* is the same as the difference of potential from *c* to *e*. But the difference of potential, or the electromotive force, between two points of a circuit is the product of the current and the resistance between those points.

Therefore $C_1 R_3 = C_3 R_1$, or $C_3 = \frac{C_1 R_3}{R_1}$.

Our purpose, it should be remembered, is to ascertain for each lamp the variation in candle-power and current strength as the electromotive force is increased; for which object it is necessary to vary the candle-power by a series of steps, and take simultaneous observations of the current and electromotive force at every point. Knowing, in each case, the value of the total current, C, if we can find the ratio between the currents, C_1 and C_2, traversing the two main branches of the circuit, we shall have, not only the current flowing through the lamp, C_2, but—by multiplying the resistance of the branch, *a b e*, by C_1—we may obtain the electromotive force.

Our object is now to find the ratio between the currents, C_1 and C_2. It is evident that the electromotive force from *d* to *e* is equal to the sum of the electromotive forces on *d c* and *c e*; or using instead the products of the currents and resistances on these branches, we have

$$(C_2 - C_3) R_3 = C_3 (R_2 + R_1)$$

Substituting for C_3 its value $\frac{C_1 R_3}{R_1}$ previously found, we have

$$\left(C_2 - \frac{C_1 R_3}{R_1}\right) R_3 = \frac{C_1 R_3}{R_1} \left(R_2 + R_1\right)$$

Clearing of fractions,

$$C_2 R_1 - C_1 R_3 = C_1 R_2 + C_1 R_1$$

Transposing and combining,

$$C_2 R_1 = C_1 (R_1 + R_2 + R_3)$$

or

$$\frac{C_2}{C_1} = \frac{R_1 + R_2 + R_3}{R_1}.$$

When the resistance, R_3, of each of the equal coils of large copper wire is so small in comparison with the other resistances that it may be neglected, we may write

$$\frac{C_2}{C_1} = \frac{R_1 + R_2}{R_1}.$$

Expressing this equation in words, we say that the current passing through the lamp is to the current passing through the resistance coil, R, as the sum of the resistances of the fixed and variable arms of the bridge is to the resistance of the fixed arm.

Having thus found the ratio between the currents in the two branches of the circuit, and knowing also by observation of the ammeter the value of the total current, C, which is the sum of the two portions, C_1 and C_2, it is an easy matter to find the absolute value of the current in each branch of the circuit. The electromotive force on the branch, *a b e*, is then computed by multiplying the resistance of that branch by the current passing through it, and this gives us the electromotive force between the terminals of the lamp, after deducting the trifling amount necessary to overcome the resistance of the wire in the branch, *a d e*. The horse power expended in the lamp is then found by multiplying together the values of the electromotive force and the current, and dividing the product by 746.

The resistance, R_3, of each of the equal coils, *b e* and *d e*, was in this case only 0·424 ohm, and the fixed arm of the bridge was generally made 1,000 ohms. The value of R_3 was not neglected in the calculations, but as the error that would have been caused by its neglect would be in the fifth decimal place, its use was an unnecessary refinement.

The above method of ascertaining the electromotive force and current of an incandescent lamp possesses several practical advantages over any method in which the lamp itself forms one arm of a Wheatstone bridge. First, no special apparatus is required; second, instead of passing the entire current constantly through the coils of the bridge, we may, by adjusting the resistance of the fixed arm, reduce the current to a strength just sufficient to obtain deflections of the galvanometer; third, while the current passes constantly through the lamp, the circuit through the bridge is closed only when the key is depressed. It was found that, with ordinary care, the ratio of two currents could be thus ascertained accurately to four decimal places.

The accuracy of this method of comparing currents evidently depends upon the exact equality of the resistances of the two coils, *b e* and *d e*. They consisted of No. 6 copper wire, covered with paraffined cotton braid. Such wire will carry 50 ampères without warming perceptibly, and as the currents used in these experiments rarely exceeded two ampères, there was no danger from unequal heating of the two coils. Before beginning the tests, these coils were adjusted to equality by means of the Wheatstone bridge, the final adjustment being made by a sliding contact resting on the wire, with the galvanometers so sensitive that a variation of $\frac{1}{1000}$ of one per cent. was perceptible. Their equality was again tested at the close of the work. To insure that the two coils should always be at the same temperature, they were wound on a frame into a single loose coil.

It was also important that the resistance of the coil, R, should not be altered by the passage of the current. This coil consisted of about 200 ohms of No. 18 German silver wire. It was wound with silk, and hung loosely over a frame, so that the air could circulate freely through it. The current traversing it never exceeded one ampère, and was generally much less, so that it did not warm perceptibly. This coil was also arranged so that it could be instantly taken out of the circuit and connected with the bridge, and its resistance measured at intervals during the progress of a test. It was found that the error due to the heating of this coil never exceeded $\frac{1}{10}$ of one per cent.

This part of the work was carried on at times by two observers, one of whom observed the ammeter and the bridge, while the other took simultaneous observations with the photometer. At other times the writer alone took all the observations, reading first the ammeter and the bridge, then the photometer, and then, to insure that no change had occurred, again reading the ammeter and bridge.

THE PHOTOMETRIC TESTS.

In these, and all the observations with the photometer, five or more readings were taken at every point, and their mean used as the true reading. After considerable practice, these photometric readings could be made quite exactly.

In these measurements a Carcel lamp, burning colza oil, was used as a standard of light, the employment of a candle for this kind of work being impracticable for various reasons. In order to obtain as steady a light as possible from the Carcel, the top and bottom of the flame were diaphragmed off, and only the middle, or least variable portion, was used as a standard. The width of the aperture was adjusted so that the lamp gave an average of about 10 candle-power.

Though the light of the Carcel lamp was not subject to sudden fluctuations, like that of a candle, and would remain practically constant during a single series of observations, there was nevertheless a slow variation, due to the gradual crusting over of the wick, and to differences in the temperature of the room at different times. The error from these causes was eliminated, as far as concerned the variation in the candle-power of each individual lamp, by taking always a series of observations in which the candle-power was gradually increased, and immediately following it by another series in reverse order in which the candle-power was decreased to the starting point.

The results of these observations, then, while showing accurately the relative changes in the candle-power of each lamp for given variations in electromotive force and current, could not be implicitly relied upon for comparisons between different lamps.

Accordingly, while the electrical quantities were here obtained in absolute measure, it was not attempted in this part of the work to measure candle-power with absolute accuracy, but merely to obtain the data from which a curve could be constructed for each lamp showing on some arbitrary scale the *variation* in candle-power with different electromotive forces.

The remaining problem was to reduce all these curves to the same absolute scale. One of the lamps was next run for some eight hours at about its rated candle-power, and very carefully compared with a standard candle, measurements being constantly taken of the candle-power, current, and electromotive force. The candle was hung on the arm of a balance made for the purpose, and the time required for the consumption of each 20 grains was noted, and the proper corrections made. Several standard candles were used, all of which burned very nearly 120 grains per hour.

The average of the above observations gives us the absolute candle-power and electromotive force for a single point on the curve of this individual lamp. To get the entire curve into absolute measure it is simply necessary to change the scale of the diagram to conform to this measurement. Having done this, we have two correct curves for a single lamp, in which abscissæ represent volts, and ordinates represent, in the one curve, ampères of current, and in the other, candle-powers.

DIRECT COMPARISON OF EFFICIENCIES.

The remaining curves were next reduced to the same absolute scale by a system of direct comparisons of the lamps at opposite ends of the photometer.

The method consisted in placing at one end of the photometer bar, a lamp whose curves of candle-power and current had been already obtained in absolute measure, and at the other end the lamp whose curve was to be reduced to that standard. The lamps were then run at their rated candle-power, and their relative brilliancy ascertained by the photometer.

If the two lamps were of the same kind, or required about the same current strength to bring them to their normal brightness, they were connected in series, and the strength of the current through both ascertained by the ammeter. In other cases they were placed in multiple arc, adjusted to the proper relative candle-power by a variable resistance in one branch of the circuit, and the current through each branch measured by the bridge method.

By thus obtaining accurately the ratio of the currents flowing through two different forms of incandescent lamps, while they are running at a given relative brilliancy, and knowing, from our previous experiments the ratio of the resistances of the two lamps with these given currents, the *relative efficiencies* of the lamps are ascertained independently of the absolute measurements.

Having obtained in this way the relative candle-power of two lamps at two given points on their respective curves, it is simply a matter of altering the scale of one diagram to bring both to the same absolute standard.

The great advantage of this comparative method lies in the fact that as but one absolute determination of candle-power is made, this one can occupy a good deal of time, and be made with great care; and further, that as the *relative* efficiences of the different lamps are ascertained by comparing the light of one lamp directly with that of another, while at the same

time the relative values of the currents and electromotive forces are obtained by direct comparison, any errors that may be made in the absolute measurements will affect all the lamps alike, and *cannot alter the relative efficiencies.*

It is, of course, impossible in a brief memoir to describe all the details and precautions against error employed in work which extended over a period of about two months. Therefore, having given a sufficient account af the methods used to enable one to form a fair idea of their reliability, we now pass on to consider

THE RESULTS.

The first result of the experiments just described was a series of curves, showing, for each individual lamp tested, the value of the current strength in ampères, and the candle-power, for a range of electromotive forces, from the point where the carbon is barely incandescent, to a point where the lamp is giving four or five times its normal candle-power. These results were carefully averaged for each class of lamps. The method of averaging was to take lamps of the same kind—not at the same candle-power, but at the same electromotive force, as they are intended to be run in practice—and find, from the curves for the separate lamps, the values of the candle-powers and ampères at intervals of five volts. Then the average of these values was taken at each point; the average resistances being computed by dividing the number of volts by the average number of the ampères. This gives to all the quantities the same mean values which they would have in an actual case, where the lamps are run in multiple arc.

The results of these experiments indicate that the essential factor in the efficiency of an incandescent lamp is not high resistance, but high incandescence. The Maxim lamps, which displayed the highest efficiency, gave a slightly whiter light than the others, showing that the carbons were heated to a higher temperature; though their resistance was lower than that of the Edison lamps. The fact that a low resistance filament is usually coarser than one of high resistance would tend to make it endure equally well at a higher temperature.

CLARKE'S ELECTRIC GAS LIGHTER.

THE Electrical Apparatus Company, of 58, Queen Victoria Street, and Charing Cross, whose name we have already mentioned several times in connection with the manufacture of novel and ingenious electrical apparatus, has now brought out "Clarke's New Frictional Electric Gas Lighter," the invention of Mr. Charles Leigh Clarke, of Manchester.

Our readers will remember that some time ago we gave a description of "Clarke's Electric Gas Lighter," as originally constructed with a chloride of silver battery and induction coil. We now have great pleasure in describing the new gas lighter, which we regard as a great and valuable improvement on the former. Indeed, the new apparatus is one of the most ingenious practical electrical inventions that has appeared within several years past. Additional interest is attached to it from the fact that the principle involved is that of frictional electricity, on which principle so many attempts have been made to construct a similar apparatus, but have invariably failed.

We believe we are right in asserting that this is the first time that the longest known branch of electricity, viz., that of friction, has been applied in a really useful and practical manner.

In describing this gas lighter, we cannot do better than follow the words of the inventor, Mr. Clarke, as contained in his Letters Patent, No. 5992, of 1883.

"The object of the invention," says the inventor, "is to provide a convenient, durable, and portable instrument for generating and utilising electricity for lighting inflammable gases or vapours, and for various other purposes, such, for instance, as the firing of explosive charges in mining operations, or for torpedo or artillery work. My object is attained in the apparatus which I shall hereinafter describe more especially for gas igniting purposes, and which consists, generally, in an induction generator, combined with mechanism to operate the same, and a conducting wire or wires and electrodes contained in a convenient tube, whereby the electricity generated is conducted to any suitable distance, in order to apply it to its designed purpose.

"In addition to these elements, I also provide a drying cell enclosing a drying substance, whereby the interior surfaces of the apparatus are kept perfectly dry, and its effectiveness greatly increased.

"To produce or develop the electricity necessary for the purpose required, I preferably employ a generating device, in which an electrified body is made to act by induction on a movable system in such a way as to produce a practically continuous generator of electricity, which is discharged between the extremities or points of the conducting electrodes.

"By utilising such a source of high tension electricity, I am enabled to dispense with the costly and unenduring adjuncts of electric gas lighting (*i.e.*, a voltaic battery, induction coil, and circuit breaker) which have heretofore been indispensable.

"In the annexed drawings, which form a part of this specification,

"Fig. 1 is a vertical section of the complete apparatus, with the electrode containing tube partly broken away and shortened.

"Fig. 2 is a cross sectional plan view of the cylinder, A, on the line, *a*, *a*. Fig. 3 is a cross section of the cylinders A and H, in their relative positions.

"Figs. 4 and 5 are sectional views of part of the cylinder H, slightly modified.

"Fig. 6 is a diagramatic development of the cylinders A and H, showing the electrical connection of the inductive generator.

"Fig. 7 is an enlarged and exaggerated plan of the cylinder, B, with the top plate removed.

"The entire apparatus comprises four distinct parts or elements, viz., the inductional generative apparatus, the lighting tube containing the operative or sparking points, the actuating mechanism suitably encased and furnished with means for operating from the outside, and the drying cell, charged with some drying substance or compound.

"These separate instrumentalities I design, however, to incorporate in a single instrument similar to that described in the Specification of Letters Patent granted to myself and John Leigh, bearing date the 1st day of March, 1882, No. 985.

"The inductive generating apparatus, which constitutes one of the principal elements of my invention, is specifically shown at figs. 1, 2, 3, 4, 5, and 6, and is based partly upon Varley's electrostatic machine, and partly upon the 'mouse mill' of Sir William Thomson.

"It consists, mechanically, of a hollow cylinder of non-conducting material, such as vulcanite, mounted delicately upon pivots or journals within another cylinder, and caused by proper mechanism to rotate rapidly therein. Inasmuch, as it is very difficult to clearly show in the drawings the electrical arrangements, I have in fig. 6 endeavoured to show them by supposing the cylinders to be split open and rolled out, so as to present a flat appearance.

"In the drawings, A, is the outside vulcanite cylinder, which also constitutes the external casing, and which is closed at the upper end by a partition, *p*, *p*, of like material, through which the conducting wires extend, terminating in contact springs, p^1 and p^2. The wall of this cylinder, however, extends upwards a little above the cover, *p*, *p*, and is threaded for the attachment of the lighting tube or base plate, *z*, *z*, thereof.

"Two armatures or inductors, *o* and o^1, of thin metal

foil are fastened to the internal surface of the cylinder, A, opposite to one another, each equal in width to about one-third of the internal circumference of the cylinder, A.

"Six contact springs (each consisting of a wire terminating in a small roller, or bent to a circular form at its free extremity) are permanently attached at one end to the closed end, P, of the outer cylinder, A. These are arranged in three pairs, l l, l^1 l^1 and l^2 l^2. The springs, l, l, at their fixed ends are connected together by a wire, m^1 (or fastened to the opposite ends of a light metal bar) which is let into the cover, p, p, of the cylinder, A, so that from the free end of one of the springs, l, to the other free end of the other, there is a continuous conducting path.

"The springs, l^1, l^1, at their fixed ends are permanently united to the electrode contact springs, p^1 and p^2, and provide the route for the escape and neutralisation of the electricity.

"The springs, l^2, l^2, are each connected to the projecting end or terminal of one of the inductor armatures, o and o^1.

"The inner hollow cylinder, H, has an axis, u, u, extending through it from one end to the other, terminating at both ends in an arbor or journal, by which the cylinder is rotatable in suitable fixed bearings, the upper bearing being a brass bush screwed into the centre of the cover, p, p (or if a metal bar joins the springs, l, l, formed in the centre thereof), while the lower bearing is in the lower or base plate, b, b, of the metal motor case, B, hereinafter described. The cylinder, H, is provided with 6 metal foil carriers or conductors, m, m, each carrier being a strip of foil, extending nearly the whole length of the cylinder, and having a width of about three-eighths of an inch. If preferred, the carriers may be supported upon discs at each end instead of the cylinder, H.

"These are preferably cemented to the interior surface of the cylinder, H, and terminate at the lower end in a series of metal buttons or studs, n, n (or short stips of metal as shown at figs. 4 and 5) which project for a short distance into the cylinder, H, or are turned flush with the surface of an extra thickness of vulcanite at the lower part of the said cylinder.

"The carriers, m, m, have no electrical connection with one another, or with the electrodes or inductors, o, o^1, except by means of the curved ends, r, r, of the contact springs, l, l^1, l^2, which are brought into contact successively with the carrier buttons or plates, n, n.

"When the cylinder, H, is revolved, each carrier, m, m, is brought into successive contact through the contact springs, l^2, l^1, l, with the armatures, o and o^1, the electrode wires and sparking points, and the short circuiting wire, m^1, m^1 (or bar). The lighting tube, E, is in metallic connection by means of its base plate, Z, with the spring, p^2, p^2, and is provided at its end with a point, k, which thus forms one of the sparking points, the other point, k^1, k^1, is at the end of the central wire, k^2, k^2, which is in metallic connection with the spring, p^1, p^1, and I prefer to form a condenser in this tube by casing the wire, k^2, k^2, in the foil, and passing it through an insulating bush, k^3, k^3, which is also wrapped in tin foil. The central wire, k^2, k^2, at its lower end makes contact with the contact spring, p^1, p^1, which terminates the wire spring, l^1, and passing through the tube, terminates at its upper extremity in the spark point or electrode, k^1, k^1.

"Between the points, k and k^1, when the apparatus is operated sparks freely pass.

"The point k consists preferably of an adjustable screw by which the distance between the points can be controlled.

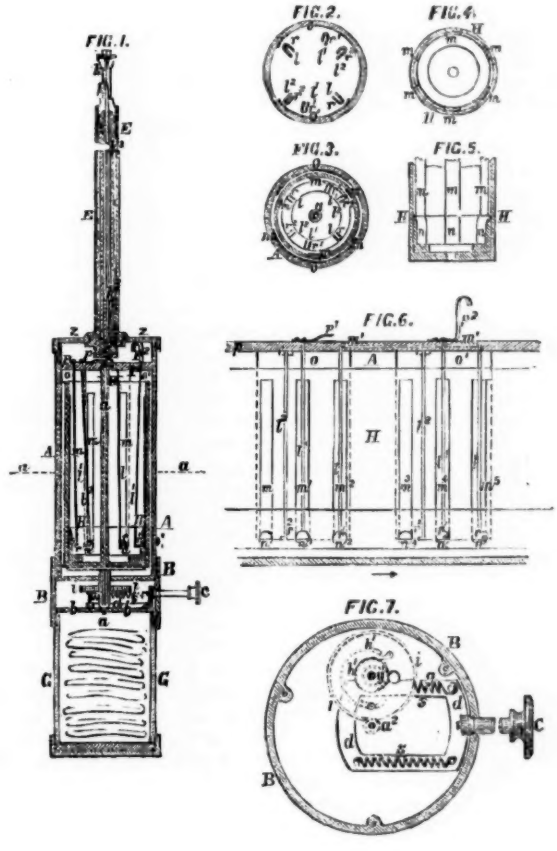
"The lighting tube, E, screws into the metal plate, Z, which, in turn, screws on to the outer cylinder, H.

"If preferred, two wires suitably insulated may be used inside the tube, E, one in metallic contact with the spring, p^1, and the other in connection with, p^2, their unprotected ends projecting at the sparking points in the said tube.

"This arrangement practically constitutes a condenser (or rather two condensers); the wires forming inner conductors, the insulating material the dielectric, and the tube an outer conductor common to both. I will now describe the actuating mechanism of the induction apparatus, which is separately enclosed in a metal compartment, B, screwed to the cylinder, A, and also to the drying chamber, g, forming a connecting link between them.

"In addition to the parts shown in fig. 1, the mechanism is also shown by the exaggerated plan view, fig. 7. The spindle, or axis, a, a, of the inner cylinder, H, passes through the cylinder, B, centering at its end in the lower plate, b, a pinion, a^2, a^2, is fixed to the spindle, a. This pinion is engaged by the spur wheel, i, i, and a second pinion, g^1, g^1, on the arbor of the spur wheel gears with the rack, g, g, carried on the movable frame, d, d, this frame being attached to and actuated by the push button, c, c, the shank of which passes through the casing, B. The interior of this hole in the casing, B, is fitted with a valve seating so that when the button is retracted the whole is air tight.

"The spur wheel, i, i, works loose on its arbor as is maintained in mechanical connection with the said



arbor and pinion, g^1, g^1, when the button, c, c, and movable rack frame, d, d, are being pushed inward by the ratchet and pawl, h^1, h^1. When, however, the pressure is removed from the push button, c, c, the said button and its spindle are retracted by the spiral springs, s, s, fixed to the interior surface of the casing, B, B.

"When so retracted the pawl slides backwards over the ratchet teeth so that all backward movement of the cylinder, H, is prevented.

"The inner cylinder, H, of the induction machine is thus readily revolved by simple pressure of the thumb upon the button, c, c.

"The only undescribed part of the instrument is the chamber, g, screwed to the part B, and forming the base of the handle; it may be formed of any convenient

material, and is filled with blotting paper, muslin, or other suitable fabric permeated or saturated with chloride of calcium, or other similar absorbent or drying substance or compound. By the use of this chamber, *g*, the working of the apparatus is improved and its efficiency greatly increased.

"The operation of the instrument is as follows :—

"When the instrument is to be used the button, *c*, *c*, is pressed inwards by the thumb or fingers and causes the cylinder, H, to revolve rapidly, thus developing electricity in the following manner.

"The inductors, or armatures, *o*, o^1, may be regarded as having always a somewhat different potential, so that one practically has a slight positive, and the other a small negative charge ; it is, in fact, found to be difficult, if not impossible, to reduce them to the same potential ; and as the smallest conceivable charge on one inductor of the machine is sufficient to start it after a few revolutions of the inner cylinder, the inductors and carriers become highly charged, and discharge themselves by means of the electrodes.

"Referring now to the diagram, fig. 6, we may assume, therefore, the armature, or inductor, *o*, to have a small initial charge of electricity (say positive). The cylinder, H, carrying on its interior surface the foil carrier, *m*, m^1, m^2, m^3, m^4, m^5, is supposed to be revolving in the direction of the arrow. The inductor, *o*, will induce a negative charge through the substance of the revolving cylinder in the carrier, m^2, as the said carrier rotates past the contact spring, *l*. The carrier, m^2, makes momentary contact with the round head, *r*, of the said spring, and the positive electricity flows by way of the contact spring, *l*, metal wire (or bar) and complimentary spring, *l*, to the opposite carrier, m^5, charging it positively. The negative charge of the said carrier, m^2, is by the continued rotation of the said cylinder, H, conveyed onward until the next contact spring, *l*, is reached and the round end, r^2, of that spring impinging on the carrier conducts the said charge away to the second inductor, o^1, augmenting the original negative charge and leaving the carrier, m^2, almost neutral.

"As the said carrier continues to rotate past the inductor, o^1, a positive charge is induced in it, and what negative charge there is remaining flows off by the second contact spring, *l*, which by this time is reached. Still passing on, the positive charge, *n*, *n*, is brought to the first inductor, *o*, and as the carrier makes contact with the round end, r^2, of the spring, l^2, the said carrier is transferred to the inductor, *o*, augmenting the original positive charge existing therein. When the same carrier, m^2, again passes the first spring of the pair, *l*, it receives by induction from the inductor, *o*, through the substance of the cylinder, H, a greater negative charge than before, which is again carried on to augment the negative charge in the inductor, o^1, thus inducting a strong positive charge in the carrier, m^2, as it passes that inductor, which charge is for the second time added to that in the first inductor, *o*. Each turn thus augments the charge on both inductors in a constantly increasing ratio, and the only limit to the charge which can thus be accumulated on the inductors is that determined by the third pair of contact springs, l^1, l^1, leading to the sparking points, *k*, and k^1 ; and when the difference of potential between the inductors becomes sufficiently great, the electricity instead of continuing to augment the charges of the inductors is delivered by the carrier to the contact springs, l^1, l^1, and passes up through p^1 and p^2, to the points, k^1 and *k*, re-combining in the form of sparks, in a continuous supply, the condenser aiding in the effectiveness of the sparks. I have merely described the operation of one of the carriers, but it is very evident that the same succession of electrical changes is continually occuring in all of them, the whole working harmoniously together, first to excite the conductors to their maximum capacity, and then to conduct the surplus electricity by way of the sparking points."

We have only to add that we believe that the apparatus will fully answer all that is claimed for it, and that it will come into very general use.

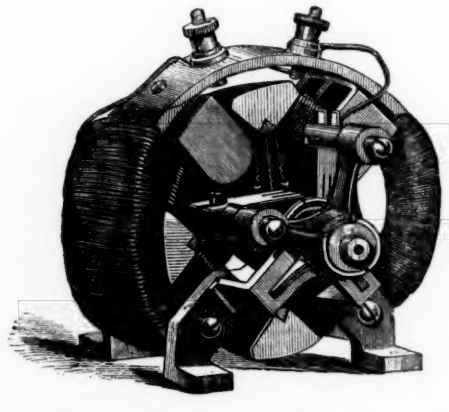
THE CUTTRISS PATENT ELECTRO-MOTOR.

IN our issue of August 2nd we published a table of tests which had been made with the Reckenzaun electro-motor. The efficiency of this apparatus is very considerable, but it must be borne in mind that Mr. Reckenzaun has brought all his ingenuity to bear upon motors of such a size as to develop a half horse-power and upwards.

The motor which we illustrate in the present article is a toy in comparison with those of Mr. Reckenzaun, but, like the Griscom apparatus, it is constructed for special purposes ; indeed, we think that the Cuttriss form of electro-motor will be found more efficient in the small sizes than when made to do a greater amount of work.

The construction of this electro-motor is as follows :—

The armature consists of two or more rings of iron suitably mounted on a central shaft, each of which has four swellings or pole-pieces corresponding to the four pole-pieces of the field-magnets. In the particular pattern illustrated, there are two of these rings, one in advance of the other, and so placed relatively to the field-magnets, that their poles alternately pass the latter, thus forming eight points of attraction equally distributed round the axis. Each of the eight spaces on the armature is wrapped with insulated wire. The coils so formed are connected together in series, so as to form one complete circuit. A wire is connected from each junction of the coils to a corresponding segment on the commutator.



Each of the pole-pieces of the two field-magnets is composed of three tongues, the two rings of the armature revolving in the spaces between them, By this means the armature is surrounded on three sides by the pole-pieces of the field-magnets, the attraction between the two being consequently very great.

To prevent the necessity of using four brushes to distribute the current on the commutator consequent on there being four distinct magnetic poles, the opposite segments of the commutator are joined together, thus requiring the use of only two brushes. Those brushes are supported at right angles to each other on a movable arm, by changing the position of which not only can the speed be altered at pleasure, but the direction of rotation can be reversed and the maximum speed obtained by moving the arm through an angle of not more than 90°.

The peculiar construction of the motor allows of all the metal being employed to the best advantage, thus reducing the weight to a minimum, and as the various parts are open and free to the air, it does not get hot when heavily worked. It is also self starting, having no dead points, owing to the armature never being entirely short-circuited.

Among the various uses to which the motor can be applied, it is especially suitable for dentists, replacing the ordinary dental engine worked by the foot of the operator, and when enclosed in a wood case as supplied for the purpose by the manufacturers, the noise pro-

duced when working is barely perceptible, which of itself is a great advantage, as dentists have a decided objection to noisy machinery.

Not the least important feature is the high efficiency obtained from it when working, and Messrs. Cuttriss give the following results of tests made with it to bear out this statement :—

Volts.	Amps.	Rev.	Ft. pnds.	Percentage of efficiency.
14·5	6·6	2,700	1,350	32
10·75	1·7	1,100	268	34·5

The armature of the motor illustrated is $3\frac{1}{4}$ inches diameter, the weight of the entire apparatus being somewhat under $3\frac{1}{2}$ lbs.

We have examined one of these electro-motors, and it appears to be in all respects an admirable little machine.

THE ENERGY OF A CURRENT.*

By PROF. H. S. CARHART.

THE well-known formula for the rate at which a current does work is $W = C\,E = C^2\,R$, in which the units are so chosen that the constant of the equation becomes unity. The last term of the formula expresses the time rate of doing work only when the whole work of the current consists in heating the conductor, whose resistance is R. For the present let the work of the current be restricted to its heat-producing power, excluding all mechanical work, which is reserved for discussion in the latter part of this paper. The interpretation of this simple formula under different conditions is very instructive.

First. Suppose the resistance of the circuit to remain constant while the strength of current varies. Then, since in this case the current and the electromotive force are strictly proportional to each other, it follows that the energy of the current per second varies either as the square of the electromotive force or as the square of the current. If the electromotive force be doubled, for instance, the current will also be doubled, and the product of the two, or the energy of the current, is quadrupled. If we apply this to a battery we get a concrete reason for the proportionality of the energy to the square of the current. Keeping the total resistance constant, to double the current it is necessary to double the number of cells employed. If the energy of the current per second is measured by the weight of zinc consumed in unit time we shall then have twice as much zinc consumed in each cell with the double current as before, while the number of cells is also doubled. Hence the quantity of zinc consumed in the entire battery to produce the double current is quadrupled. The increase of current implies increase of chemical action, whether it be of electrolysis in a decomposing cell, or of chemical combination in the cell generating the current, and the increase of chemical action is exactly proportional to the increase of the current. The double current, therefore, with constant resistance represents quadruple energy, because the quantity of zinc consumed in unit time is quadrupled.

Second. Suppose the electromotive force to be kept constant, and the current to be doubled by reducing the resistance to one-half. Then the current will be doubled as before, and the energy of the current will also be doubled ; or in this case, the heat energy in the entire circuit varies directly as the first power of the current. The zinc consumed in each cell is doubled ; but, since the number of cells remains the same, the total weight of zinc consumed in unit time is merely doubled. Therefore, doubling the current by reducing the resistance does not quadruple the energy of the current, but doubles it. It follows that the total heat energy is proportional to the square of the current only when the resistance is kept constant, and is proportional to the current directly when the electromotive force is constant.

Third. We may increase the current both by increasing electromotive force and decreasing resistance. The energy will be proportional then neither to the first power of the current nor to the second, but will be intermediate between the two. If the electromotive force be doubled and the resistance halved the current will be increased fourfold. These conditions imply doubling the number of cells of battery while the weight of zinc consumed in each is quadrupled. The total weight of zinc consumed is, therefore, increased eight times, and the energy of the current is increased in the same ratio.

Fourth. We may suppose the current to remain constant while the electromotive force increases. This may be accomplished in two ways. If the resistance and electromotive force increase proportionally the current is unchanged. This case offers no peculiarities, the energy of the constant current increasing with the electromotive force. The other method of keeping the current constant with increasing electromotive force, while the resistance remains constant, will be understood if we consider what happens when the current is giving up its energy in the form of mechanical work. In the preceding cases we have supposed the current simply flowing through a closed circuit, not embracing any apparatus for the production of motion. If the current simply energises an electromagnet and holds a weight, without repeating the operation, then it remains constant after the brief interval required to magnetise the cores, and is not doing any mechanical work, but is giving up energy continuously in the form of heat at the same rate as if no magnet were included in the circuit. But if motion ensues, such as the striking of an electric bell or the functioning of any other apparatus in which the attractive or repulsive force of the magnet causes any mass of matter to move continuously or reciprocatingly, the energy is given up in the form of external work. In such cases a galvanometer inserted in the circuit shows a diminution of the current as soon as the motor (for such it is) begins to work. This reduction of the current is due, not to an increase of total electrical resistance offered by the action of the motor, as Mr. J. T. Sprague asserts in the May issue of this journal (page 103), but to the counter-electromotive force set up by the reaction on the current of the moving parts of the apparatus. The motor becomes a dynamo-electric machine, tending to produce a current opposed to that of the source of electric supply. It is important to apprehend clearly that the resistance offered by the machine for converting electric energy into useful mechanical work is not in the nature of electrical resistance at all, but of counter electromotive force. An increase of electromotive force in the electric generator is, therefore, necessary when the motor begins to work, if the current is to be kept constant. The total work per second furnished at the generator is represented as before by the product of the electromotive force and the current flowing through the conductor. But this energy is divided into two parts, as represented by the equation

$$E\,C = C^2\,R + E^1\,C,$$

in which E^1 is the counter electromotive force due to the motor and R is the entire resistance in circuit, including that of the generator and of the motor. The first term in the second member of the equation expresses the rate at which heat is given out in the circuit, while the second term represents the rate at which the motor converts electrical energy into mechanical work. From this equation,

$$C = \frac{E - E^1}{R},$$

which shows that the current will remain constant under the condition of a constant resistance, as we have supposed, if E and E^1 vary in such manner that their difference is constant. The total electrical energy of

* The *Electrician and Electrical Engineer* of New York.

the motor, however, being E C, will vary directly as the electromotive force of the supply of electrical energy. If this is a battery, the electromotive force is proportional to the number of cells; but the zinc consumed in each cell per second is constant, under the hypothesis of a constant current; so that the entire weight of zinc consumed in the whole battery is also proportional to the electromotive force. Several propositions admit of statement as universally true:

1. The total rate at which electrical energy is given out in the circuit is the product of the current and the electromotive force of the generator.

2. The rate at which work is done in the motor, measured electrically, is the product of the counter electromotive force of the motor and the current.

3. The rate at which the energy of the current is converted into heat in the circuit, is the product of the resistance and the square of the current. If no mechanical work is done this expresses also the total rate at which electrical energy is given out in the circuit; and, generally, for any portion of a circuit of resistance R, the heat generated in that portion of the circuit is expressed by C^2 R for unit time.

THE ORGANISATION OF THE POST AND TELEGRAPH SERVICE IN FRANCE.

(*Continued from page* 128.)

THE introduction of post office orders in our foreign relations, dates from the 8th of April, 1864, when a convention made with Italy authorised the exchange of money orders between that country and France. Since that time this service has successively been organised with:

Belgium	on the 1st	March, 1865
Switzerland	„ 22nd	March, 1865
Luxemburg	„ 28th	January, 1868
Great Britain ...	„ 30th	April, 1870

This last convention did not come into force until the 1st May, 1873, and then only for transactions between Paris and the United Kingdom, and on the 1st April, 1875 for the other relations:

Germany	on the 1st	February, 1876
Holland	„ 1st	December, 1876
Dutch Indies ...	„ 1st	January, 1878
Sweden	„ 1st	May, 1878
Denmark	„ 1st	May, 1878
Norway	„ 15th	July, 1878
Austro-Hungary ...	„ 1st	September, 1878

The continually increasing importance of the number of foreign post office orders shows the favour with which the public received the application of the new conventions.

On the 4th June, 1878, at the Congress held in Paris, the States of the Postal Union signed a convention for the exchange of money orders.

This convention, approved of by the law of the 19th December, 1878, and ratified in the name of France on the 27th March, 1879, came into force on the 1st April following.

It substituted uniform rules and rates for the various regulations which previously had been applied to the relations between the different countries.

All countries in Europe adhered to it with the exception of England and Spain, with which we had special conventions, Greece, Russia, Servia, and Turkey. Amongst the adhering countries were Egypt, Portugal, and Roumania, with which France previously did not exchange money orders.

From 200, 300, or 375 francs the maximum of the foreign orders has been increased to 500 francs, and a uniform rate of 25 centimes for every 25 francs or fractions of 25 francs has been substituted for a rate of 20 centimes for every 10 francs, or an average reduction of 50 per cent.

The following tables show the development caused by the new regulations.

FOREIGN POST OFFICE ORDERS ISSUED IN FRANCE AND ALGIERS SINCE 1877.

YEARS.	Number of Orders.	Amount. Francs.	Rates Received. Francs.
1877	314,619	13,176,768·43	277,810·06
1878	392,469	16,870,493·51	354,837·98
1879	492,902	22,483,746·52	326,974·66
1880	621,381	30,704,756·60	391,640·67
1881	733,682	37,184,982·07	469,129·38
1882	854,099	44,386,405·22	553,452·35
1883	897,557	47,401,631·86	562,365·24

Comparing 1883 with 1877 we notice an increase of 582,938, or 185 per cent. in the numbers of orders; of 34,224,863 francs, or 259 per cent. in their value; of 284,555, or 102 per cent. in the receipts, notwithstanding the reduction of the tariff.

NUMBER OF ORDERS ISSUED IN FOREIGN COUNTRIES AND PAID IN FRANCE.

YEARS.	Number of Orders.	Amount. Francs.
1877	203,290	9,536,190·72
1878	233,590	11,260,883·60
1879	266,975	14,040,910·61
1880	309,263	17,685,408·60
1881	345,783	20,033,009·51
1882	381,122	22,035,172·15
1883	429,453	23,819,166·40

Or an increase of 150 per cent. in the amount of the orders paid in 1883, as compared with 1877.

The question of extending the exchange of telegraphic money orders to our relations with foreign countries, is being considered.

In England an important innovation has lately been introduced in the service of the post office orders; it has immediately called for our attention. This innovation consists of the creation of postal orders of a fixed amount.

After a description of this new service and the results obtained in England, we read the following:—

The poundage charged in our country for post office orders is considerably lower; it even can be as low as one centime, whilst in England it is never less than 20 centimes. Besides, in France, any order under 300 francs can be paid in any post office.

These postal orders, nevertheless, appeared to us to offer certain advantages, and we have not hesitated to present a project for a law to authorise us of introducing the system into France. This project has been voted by the Chamber of Deputies on the 9th June, 1882, and by the Senate on the 25th June, 1882.

Postal orders of a value of 1, 2, 5, 10 and 20 francs have been created and placed at the disposal of the public at all offices; they advantageously replace for the sender, the addressee and the Administration itself, the former orders of the same amount, the number of which is considerable; thus in 1881, 5,100,000 orders had been issued, the value of which corresponded exactly with the value represented by the present postal orders. These orders, the accounts of which are much more simple than those of the present post office orders, are issued blank; the sender fills in the name of the person to whom the amount is to be paid, and payment is made on receipt from the person named. The quickness with which they are issued and the facility with which they are paid, allow of avoiding of having to wait at the "guichets"; they also simplify the work in the offices.

The poundage to be paid is fixed at 5 centimes for postal orders of 1, 2 and 5 francs; at 10 centimes for those of 10 francs, and at 20 centimes for those of 20 francs; and by decree, it could be reduced by one-half for orders of 10 and 20 francs.

The difficulties of the manufacture did not allow of supplying simultaneously postal orders of all the values to the whole of the post offices. Orders of 5 francs have been issued in November, 1882; those of 20 francs, in December, 1882; those of 1, 2 and 10 francs, in January, 1883. But by the end of February, 1883, the distribution of postal orders, of all values, was completed and all the offices in France were supplied with them. This gradual distribution in supplying the offices has, up to the present time, not allowed of making any accurate statement of the working of this new service.

The post and telegraph service of Paris is, of course, the most important of all. As the capital is the place where all the railways meet, it is the centre to which the principal part of the inland and foreign correspondence converge.

The exceptional importance of the postal and telegraphic traffic in Paris, therefore, is due, not alone to the considerable number of correspondences intended for, or coming from that town, but Paris is also the transit of a very considerable fraction of the correspondence exchanged between departments themselves and with foreign parts.

All the objects of correspondence collected by each of the 83 auxiliary offices of the town from the different boxes in its circumscription, are subjected to a preparatory sorting, which consists of—1, letters for Paris; 2, letters for foreign parts; 3, letters for the suburbs (*i.e.*, for the localities of the environs of Paris, which receive their correspondence direct from the central office); 4, letters for the parishes annexed in 1860 (these letters are delivered by offices in those parishes and not by the central office, the delivery service of which works in the rest of Paris); 5, letters for the travelling offices.

As we stated before, the number of collections in Paris has been increased, since the 1st June, 1878, from 7 to 8.

Independent from the eight daily collections, a special collection is made, beginning at 3 o'clock in the morning, from the boxes of the offices in New Paris, and at 4 o'clock, from the boxes of the offices in Old Paris.

Besides, in 28 offices, within the limits of Old Paris, collections are made with extra rates; and at the central office, 24 supplementary collections take place, beyond the general collections.

The boxes at the offices contain four compartments, labelled Paris, Departments (country), Abroad, Printed matter; this prepares the work of sorting, by making the public share in it.

All the objects of correspondence forwarded by the offices are taken, eight times a-day, by 13 lines of mail carts to 17 special offices, called "bureaux de passe," of which the office of origin is the "Satellite."

These "bureaux de passe" distribute the correspondence intended for the country and for abroad between the different travelling offices. They add to their post bags special bundles of objects of correspondence, already prepared by each of the "Satellite" offices, for the outskirts and for Paris.

The correspondence thus collected is taken to the central post office.

There are in the central office four departments, and the whole is under the management of a principal director, assisted by six chiefs of departments and 20 assistant-chiefs of departments. The number of clerks of all grades, which at the central office alone amounted to 313, in 1877, has had to be augmented because of the enormous increase of the work, with 289, or 92 per cent., and thus amounts to 602; the number of sorters, carriers and others for the same service, has during that time been increased from 1,081 to 1,789.

The transferring department receives the post-bags proceeding from the other departments of the central station or from the offices in Paris, as well as those which the travelling offices forward either to the central station or to the other travelling offices. All post-bags which arrive at or are sent from Paris have to pass through the transferring department, except a few that are sent to the railway stations by adjacent offices or carried direct from one railway station to another.

In the forwarding department the sorting and the expedition of the numerous correspondence handed to the central office take place.

It comprises five sub-divisions, viz.: 1, letters for the suburbs (the localities of the environs of Paris, which receive their correspondence direct from the central office); 2, letters for the rest of France; 3, bills; 4, newspapers and receipts; 5, correspondences for abroad.

Up to the end of the year 1880 all the correspondence for nearly the whole of France were forwarded in a lump by the central office to the different travelling offices, which had to distribute them between the offices of destination. Since the month of December, 1880, the central office forwards the correspondence direct to 150 of the principal towns in France.

This improvement relieves the heavy work of the travelling offices, which have to be relieved as much as possible, as it is more costly, more fatiguing, and less sure than that of the sedentary offices; besides, it avoids useless handling and the chances of making mistakes.

The sorting of the objects between the different travelling offices and the different corresponding sedentary offices varies according to the hours, as certain localities served by the night-travelling offices are not done so by the day-travelling offices, or receive their correspondence direct in the middle of the day. This service, therefore, offers special difficulties because of the quickness and the certainty with which it has to be executed. It requires experienced clerks.

In England this is done by special clerks, called sorting-clerks, who are permanently engaged on the same work. We are busy in organising a staff of sorting-clerks for the central office, so as to obtain in the staff charged with the sorting a fixity, which it is hardly possible to obtain with ordinary clerks.

Since the 1st December, 1879, we have organised at the central office two night staffs, each consisting of 27 clerks and 7 porters, whose duty it is to sort, between 9 o'clock in the evening and 4 o'clock in the morning, the newspapers and other printed matter to be forwarded by the mails in the morning, and the different correspondence proceeding from the last collection or posted during the night.

A special allowance of 200 francs is granted to the clerks of the central office on this night duty. Besides, gratuities of 200 francs reward those clerks who perform the quickest and surest sorting.

The receiving department is charged with the delivery of the correspondences in Old Paris, as the different offices of the parishes annexed in 1860 continue to serve the districts situated beyond the outer boulevards like so many separate towns.

Old Paris is divided for the service of the delivery of letters in 11 districts, called "rayons." The letters are first distributed by the travelling offices between those districts, a central district receiving the correspondence, the incomplete addresses of which do not allow of classing them in their proper districts.

At each district office a brigade of postmen, under the superintendence of clerks, a chief and a senior postman, divide the correspondence amongst them, and sort them according to the beats, and then each postman classes them in the order according to which they should be delivered.

A brigade of postmen has scarcely left the room where the preparatory work of a delivery is done or another brigade replaces them to prepare the next delivery.

In the parishes annexed in 1860 the delivery service is performed by postmen who start from the offices situated in the parts they serve.

As we have said before, Paris had in the month of June, 1878, seven deliveries per day, since that time it has eight daily deliveries. So as to be able to do this it has been necessary to create a fourth brigade of delivery, consisting of 294 postmen.

Because of this appointment and that of 175 clerks, successively appointed during the last six years, the first, third, and eighth deliveries have been accelerated. The first delivery, which, previous to the creation of the fourth brigade, was supposed to be completed at 9.30 a.m., but which in reality lasted until 9.45, and sometimes until 10 o'clock, is at present finished at 9 a.m., at the very latest, for the whole of Paris, but with quite accidental exceptions.

Besides, previous to 1878 the last delivery on Sundays was made at 3.30 in the afternoon; all correspondence received in Paris after 3 o'clock were not delivered until the next morning. Since June, 1878, the eighth delivery, that of 7.30 in the evening, also takes place on Sundays. On that day the fourth, sixth, and seventh deliveries only are suppressed.

The creation of a second brigade of postmen, specially charged with the delivery of printed matter, has accelerated the delivery of those objects intrusted to the post, which are now included in four special deliveries.

The first delivery of printed matter, which took place at 7.30 in the morning, is now made an hour earlier.

The postmen are taken to the districts where they have to deliver their letters by a special service of omnibusses.

These omnibuses and the mail-carts, which carry to the central office the correspondence of the letter-boxes and offices of Paris, as well as the mail-vans taking the post-bags to and from the railway stations, belong to the Administration, whilst the horses and drivers are supplied by private contract.

The total number of those different carriages has been increased between 1877 and 1883 from 75 to 175, and that of the horses from 224 to 340. They make at present 882 journeys, representing 4,310 kilometres per day. In 1877 the number of journeys was 302, representing 2,421 kilometres.

(To be continued.)

THE PHILADELPHIA ELECTRICAL EXHIBITION.

PREPARATIONS are being vigorously pushed forward for the approaching Electrical Exhibition at Philadelphia. The building itself is practically complete, and foundations are now being laid for the five engines which are to propel the machinery during the exposition. The magnificent electrical fountain, which is to occupy the centre of the hall, is partially finished.

The following rules and regulations have been adopted by the committee on electrical installation, for the purpose of securing the highest possible safety both to life and property:—

1. All space granted to exhibitors in the International Electrical Exhibition must be occupied in accordance with the rules and regulations of the Committee on Electrical Installation, and all exhibitors must agree to submit to the said rules before such space is allotted to them.

2. No circuits shall be run in the exhibition buildings until full plans and particulars thereof are first submitted to the committee, and approved by them.

3. No changes shall be made in any circuits without the consent of the committee.

4. Any question pertaining to the installation of electrical apparatus, that does not fall within the scope of these rules, must be referred to said committee for decision.

Circuits.—5. All circuits must be insulated and metallic throughout their entire extent; *i.e.*, no earth connections are to be used.

6. The conductors of all main circuits must have such a weight per running foot as will enable them them to carry the current employed without heating.

7. When circuits are taken from large to small conductors, and the large conductor carries such a current as would dangerously raise the temperature of the smaller wire, if accidentally diverted through it, an approved automatic safety device must be introduced into the circuit of the smaller conductor, whereby the circuit will be automatically interrupted whenever the current passing through the smaller conductor is in excess of safety. Similar automatic safety devices must be used in all circuits run in the vicinity of electric light and power circuits.

8. All circuit wires for electric light or power currents must be insulated with some approved incombustible material.

9. Circuit wires exposed to moisture must have, in addition to their insulating covering, a coating of some water-proof material.

10. No paraffined or wax-covered wires are to be used in situations or under circumstances where they may be exposed to a high temperature.

11. When the electromotive force of the current exceeds 300 volts, the different parts of a circuit outside the electro-generator, or the apparatus which it energises, must not approach one another nearer than eight inches.

12. Aerial wires must not have a greater drop than one foot between points of support.

13. All circuits are to be run so as to permit ready and frequent inspection by the committee.

14. When practicable, the positive, or outgoing conductor must be clearly marked so as to distinguish it from the negative, or return conductor.

15. As far as practicable, continuous wires must be employed. Whenever joints are necessary, they must be made in such a

manner as to insure a good and durable contact, and said joints must afterwards be insulated.

16. Wires fastened to walls and ceilings must be rigidly attached to the same by suitable insulating fastenings. In no case will loose loops in the same be permitted.

17. Where circuit wires pass through walls, floors, or ceilings, a special insulating, incombustible tubing must be used to encase the wire.

18. All electric light and power circuits must be tested as often as the committee may direct, for accidental earths, or contacts, and if such are found, the currents shall in no case be permitted in such circuits until such earths or defects are removed.

19. No circuits shall be placed underground within the building.

20. All underground conduits, in use as such, must be placed outside the main building, as may be directed by the committee, and all circuits connected therewith must be provided with safety devices.

Systems of Electric Lighting.—21. Dynamo-electric machines must in all cases be thoroughly insulated from the ground, and be surrounded by a railing so as to prevent the approach of the public nearer than two feet.

22. All dynamo-electric machines must be furnished with means to prevent the dangerous heating of their coils on the extinguishment of part of their lights, and if such means be not automatic in action, a competent person must be in charge of the machine while it is running.

23. Electric arc lamps must be provided with an automatic switch, or cut-off, so that the lamp will be automatically cut out from the circuit whenever the current traversing its coils reaches a dangerous limit.

24. All electric arc lamp frames must be insulated and provided with a hand-switch to cut out the light when so desired.

25. All electric arc lights used in the building must be protected by glass globes, furnished with a wire netting outside the globe, to keep the globe in place in case of accidental fracture. Broken or cracked globes must be promptly replaced by sound ones. The base of the globes must be enclosed so as to prevent the fall of heated particles.

26. A suitable device must be placed on all arc lamps to prevent the fall of the lower carbon, on the failure of its holder.

27. The committee reserve the right to adopt the special preventatives in all cases where the safety of the public seems to demand it.

28. The committee reserve the right to modify these rules in particular cases where it is considered that circumstances warrant such modifications.

29. In all cases requiring prompt action, the exhibitors must be governed by the decision of the electrician until the matter can be acted upon by the committee.

EDWIN J. HOUSTON, *Chairman*,
HENRY MORTON,
CHARLES M. CRESSON, M.D.,
W. P. TATHAM,
M. B. SNYDER.

NOTES.

Electric Lighting.—The Roman Catholic church of St. John, built by the Marquis of Bute, at Old Cumnock, Ayrshire, has recently been fitted throughout with the electric light under the personal superintendence of Mr. William Massey, of Twyford, electrical engineer to the royal palaces. There are in all about 70 glow lamps of 20 candles each, and the effect is very perfect, the architectural features of the building having been carefully studied and the lamps arranged with due regard to the character of the place. The necessary current is supplied by means of a dynamo and steam engine placed in a small house hidden among the trees of the churchyard, where it is also intended to generate electricity for working the organ bellows.

From a Parliamentary return respecting the Private Bills of the past session, we gather that of the bills relating to the supply of gas, there is a considerable falling off from last year; and in the case of the electric light, a still greater falling off is noticeable, there being only four applications to the Board of Trade for provisional orders under the Electric Lighting Act of 1882. One of these—the Edison and Swan United Electric Lighting Order Confirmation Bill—transfers to the Edison and Swan United Electric Lighting Company, Limited, all the rights, powers, and obligations conferred on the Edison Electric Light and the Swan United Electric Lighting Companies.

The Central Hall and courts of the Royal Courts of Justice will not at present be open to the public, as has usually been the practice during former vacations, in consequence of the alterations being effected by the substitution of stronger boilers for the present ones in use for driving the engines for generating the electric light and for illuminating the courts and buildings.

An experiment has been made in Vienna which, it is claimed, proves that even with incandescent lights special precautions must be taken to avoid any risk of fire. A lamp having been enveloped with paper, and a current passed through the filament, the heat generated was sufficient to set fire to the paper, which burnt out and caused the lamp to explode.

We learn from America that Judge Shipman has just filed his decision in a very important patent suit brought by the Brush Electric Company against users of the Weston electric light apparatus. The defence has been conducted by the United States Electric Lighting Company, manufacturers of the apparatus, and the trial has occupied nearly four years. The testimony taken covers over 2,000 printed pages, and the oral argument before Judge Shipman in March last occupied eight entire days. The suit was upon the two principal patents granted to Charles F. Brush, one for metal plated carbon points, and the other for an electric arc lamp, which, it was claimed, controlled the entire business of electric arc lighting. Before the argument the plaintiffs withdrew the carbon patent, and Judge Shipman now decides that the lamp patent is invalid and void and dismisses the bill, with costs, as to both patents.

On Monday evening the steamer *Angus* left Dover and proceeded into the Channel in the direction of Varne Bank for the purpose of continuing observations of the experimental lights at the South Foreland.

The arrangements have been completed between a syndicate of gentlemen in Detroit and the American Electric and Illuminating Company, of Boston, to build a 200-light station in Detroit, to be equipped with Thomson-Houston lights. Work will begin at once, and 100 lights will be in operation in the course of a few weeks.

The *Era* says:—Mr. Edgar Bruce, whose theatre is illumined by the electric light, will, in defiance of the high temperature, keep his establishment open during the autumn, and "Called Back" will probably run on till Christmas.

The Chinese seem to have commenced the march of progress after all. Their third ironclad corvette, the *Tsi Yuen*, which has just left the stocks for a trial trip, is fitted with the electric light. During some operations with the light quite a scare was created on shore, the people imagining the new ship to be a French man-of-war containing some diabolical implement intended for their annihilation.

At a meeting of the Greenock Town Council on Tuesday last, the minutes of the electric lighting committee contained the following report by Mr. Stewart, gas manager:—"I have to report that seven offers for the supply of electric lighting plant have been received, as follows:—Messrs. R. E. Crompton & Co., £1,050; Mr. E. Beckingsale, £1,040; Maxim-Weston Electric Co. (per Mr. H. Watt), 1,065 10s.; Messrs. Muir and Mavor, £943; the Anglo-American Brush Electric Light Co., £1,186 11s. 8d.; Messrs. H. Bennett & Co., £1,000; Messrs. J. D. Andrews & Co., £900. With respect to offer No. 1, no details of estimate are given, or any explanations. Offerer No. 2 gives long explanatory letter containing a good deal of useful information, and detailed offer, and also alternative tender for apparatus without the wire. Offerer No. 3.—This is for arc lamps only, and two dynamos only, and offer is otherwise not consistent with specification. Letter giving explanation is with offer. Offerer No. 4 is in terms of specification. Offerer No. 5 includes wood trough and other apparatus not in the specification, amounting in all to £275, which deducted from

amount of offer, £1,186, leaves £911 11s. 6d. as nett amount of offer for comparison. This offer also includes the using of Callenders' bitumen coated wire, which is preferred, I am told, to the Kinetic Co.'s double-leaded coated wire. Offerer No. 6 is a lump sum, without details, except a general statement in letter. Offerer No. 7 is also a lump sum, and includes cost of laying wires in wooden trough of their own pattern. Messrs. Siemens & Co. declined to offer, and Callenders' Bitumen Telegraph Co. have included their offer with the Anglo-American Brush Co., and send letter explaining why their wire is preferred over the Kinetic Co.'s wire." The committee agreed that the convener, Mr. Stewart, and Mr. Wilson, C.E., be authorised to consult Professor Jamieson, Glasgow, regarding the sufficiency of the specification and offers, and report to a future meeting. The clerk was authorised to give the statutory notice to the Postmaster-General, prescribed by the electric lighting provisional order.

The Post Office and the Telephone.—A correspondent writes to a Glasgow contemporary :—"The concessions which the Government have given to the telephone companies surprised nobody so much perhaps as the companies themselves, and I hear on good authority that there is every likelihood of a great addition being made immediately to the number of exchanges in this city. The public, however, will never get the full use of the telephone to which they are entitled unless the Post Office cease altogether to interfere with the working of the system. If any one thing has been made clear by the frequent discussions of the question it is that the telephone will not diametrically affect the telegraph ; indeed, all experience shows that the more telephonic work is increased so does telegraphic work also increase. The Act under which the telegraphs were acquired was a very bungled piece of legislation, and it is absurd that it should be allowed to stand in the way of the public being served by other means. It is to be hoped, then, that not only oral but written messages will shortly be allowed, and that outsiders can, by paying a small fee, hold conversation with any subscriber they wish. Indeed, it is expected that 'penny' telephone messages will before long become an institution."

Telephony in Connecticut.—The United States Telephone Manufacturing Company has sent a circular to every subscriber of the Southern New England Telephone Company announcing that it is the owner of various letters patent granted to James W. McDonough for inventions relating to telephones ; that the instruments known as the "Blake transmitter" and the "Bell receiver" are infringements of those patents ; that suit has already been brought in the Circuit Court against one of the companies using the instruments named ; and that it is the intention of the company to enforce its rights against all infringers, whether makers or users.

"We do not learn," says the New York *Electrical Review*, "that this action has resulted in any great 'scare' among the Bell subscribers, nor that the stockholders of the Southern New England Telephone Company have taken any special alarm. But it is an interesting incident in telephone litigation, and the result will be watched with much interest."

Telephone Facts and Fiction.—Replying to the letter of Mr. Randall to the *Electrical World* (New York), which we re-produced last week, Mr. E. Berliner writes (in a later number of the *Electrical World*) : "The many misstatements in Mr. Randall's last letter are closely parallel to Prof. Thompson's attempt in his well-known book to mislead those who are not fully versed in telephonic matters. It is therefore with an apology to the majority of your readers that I remind the few others who have not followed telephone history closely, of the fourth claim of Bell's patent of March 7, 1876, which reads : 'The method of producing undulation in a continuous voltaic circuit by gradually increasing and diminishing the resistance of the circuit, or by gradually increasing and diminishing the power of the battery as set forth.' I think that in view of such gross misrepresentations as are contained in Mr. Randall's letter I am entitled to an excuse when I decline in future to discuss telephone rights and inventions with that gentleman."

Long Distance Tests.—A dispatch of July 28th from Hartford, Conn., says : A test of telephoning over a long distance was successfully accomplished to-night. The experiment was made in this city by the United States Telephone Company with the McDonough telephone. The station in this city was in the Charter Oak Life Insurance building, which was connected with the station of the Bankers' and Merchants' Telegraph Company, at No. 187, Broadway, New York. A metallic circuit, connected over the wires of the Bankers' and Merchants', was put in service through Philadelphia, running into the office at New York and completed at Hartford. This gave a speaking distance of over 350 miles. This test was very successful ; every articulation was distinctly heard, the operator in New York pitching his voice at different modulations, and every intonation was distinctly recognisable. A general conversation relative to the weather, politics, and current events, was carried on with ease.

Cable Repairs.—We learn from the *Monthly Correspondent*, the interesting production of the Brazilian Telegraph Company's staff at Madeira, that the *Scotia*, after having completed the laying of the new duplicate St. Vincent-Pernambuco section of cable, repaired the two breaks in the old Madeira-St. Vincent cable (No. 1). The first break occured early in July, 350 knots from Madeira. This, at Madeira, was made the occasion for some very interesting electrical tests, which were all the more satisfactory, seeing that there was a second cable available for "loops." A second break occurred about a week after the first ; this time about 7 knots from St. Vincent, and in the *shore-end*. Since the double repair, the *Scotia* has reported the insulation of the cable in question to be practically perfect.

The Bennett-Mackay Cable.—Mr. G. D. Roberts, who is stated to be interested financially in the Bennett-Mackay Atlantic cables, is reported as saying that the cables will be ready for public service on October 1. The cost will reach $7,000,000. The rate for cablegrams will be materially less than by the old cable, but how much less Mr. Roberts declined to say.

The New Cable to the Channel Islands.—The Post Office telegraph ship s.s. *Monarch* left the River Thames, on Monday, the 18th inst., *en route* for Guernsey, with the greater part of the new 3-conductor cable, which will be laid between Guernsey and Dartmouth. It is the intention first to land the shore end at Guernsey, and to lay from there all main cable now on board and buoy it ; then to run to Dartmouth, land the shore end there, and buoy this as well. The *Monarch* then returns for the remaining portion of main cable.

Telegraph Revenue.—The receipts on the telegraph service from the 1st April to the 16th August, 1884, amounted to £675,000, this sum being identical in amount with that received from the 1st April to 18th August of last year.

Development of the Telegraph Service.—We learn that the new gallery which is being added to the General Post Office building on the west side of St. Martin's-le-Grand, is to be exclusively devoted to metropolitan traffic. It will accommodate 800 telegraphists and about 370 circuit wires, besides several pneumatic tubes run under the flooring. In the course of a day the number of messages dealt with at the Central Station ranges between 48,000 and 60,000, nearly half of which have to be both received and forwarded. There is also a large quantity of news messages, which frequently during the Parliamentary

session, on a busy night, exceed a half a million words. The battery cells in operation are so numerous that they occupy about three miles of shelving, and yet another mile is in course of construction to meet the requirements of the increased metropolitan traffic.

Electrical Tramcars.—At Cleveland, Ohio, we learn from an American contemporary, Mr. Walter Knight has succeeded in perfecting a plan for running street cars by electricity. A mile of track was recently prepared for it, and 40 persons were carried for as many trips over the road at a rate of speed ranging from one to 15 miles an hour, at the will of the inventor. The plan being considerably cheaper in its working than the old way, and as any number of cars can be placed on the circuit to run independently, the East Cleveland line will adopt it, and will immediately make the necessary arrangement.

Transmission of Power.—We learn that preparations for M. Deprez's experiments on the transmission of power between Creil and Paris are being actively carried on. The preliminary work is finished, and the two engines which are to supply the motive power are already in place at Creil. The collectors of the electrical machines are being constructed by the firm of Gottendorf.

How to Make Diamonds.—To transmute the baser form of carbon into the priceless diamond, says the *Inventors' Record*, has been the dream of alchemists for ages. The latest enthusiast in this field has gone to the trouble of erecting quite an extensive apparatus, by which, with the help of a force of nature, in the manifestation of a flash of lightning, he hopes to attain some tangible result. The experimenter describes his device as follows:—"If a source of heat could be obtained of sufficient intensity to liquefy carbon or charcoal," he asks, "would it on cooling assume the same crystallised form as glass? The question is, how can a heat be obtained some thousand times greater than can be produced by any quantity of galvanic cells or dynamo machines? I propose to utilise a flash of lightning in the following manner:—I have erected in my garden a long iron conductor attached to a wooden spar firmly fixed in the ground, and three wide ropes as stays. This is about 40 feet high, and the conductor extends 20 feet above it. On the top of the conductor is fixed a copper ball 8 inches in diameter; the rod is attached to the spar by iron clasps insulated with gutta percha. The rod is bent about two feet from the ground, leading into a wooden box containing a tube of biscuit earthenware, and about one inch inside diameter and one foot long. The end of the rod is connected to a piece of copper wire ½ in. thick, and passes about one inch into the end of the tube. The other end has a rod connected the same way, and passes down into the earth. The tube is filled with charcoal or any other carbon. Mr. Swan (of electric light celebrity) suggested lamp black; but this or any other conducting material could be inserted. An earthenware tube I consider preferable to glass, for if an explosion took place, which probably it would, the effects on the carbon could be better seen than among broken glass. I have never yet been fortunate enough to have the conductor struck, as thunderstorms are not very frequent in this neighbourhood." As the lightning guard of Mr. S. A. Varley is constructed precisely on this principle, and as many thousands have been in use in years gone by, we (THE ELECTRICAL REVIEW) venture to think that the latest enthusiast will not be gratified by even an explosion, much less with the glimpse of a diamond.

Electric Railway Patents.—Mr. Stephen D. Field says that the favourable decision of the Patent Office on his electric railway claims establishes his priority in America on the broadest grounds, and that the Siemens, Edison, Daft and Knight-Bentley locomotive devices touch his patent rights in half a dozen points.

The Scott Monument Lightning Conductor.—The lightning conductor originally erected on the Scott monument at Glasgow was composed of copper rods. Some time ago Messrs. Ritchie and Son received instructions to test the arrangements on this and several other of the public monuments of the city. They found serious faults to exist, not only in the conductor, but especially in its connection with the earth. In consequence of this the Town Council at one of their late meetings instructed the above firm to supply and erect a new conductor. The new conductor is a copper wire rope ⅝-inch diameter, in one length, having at the extreme top a small ball, presenting three points, each tipped with platinum, to prevent oxidation. The rope is secured on the surface of the building, and descends to the base at the south-east corner, thence by a trench to the water main with which it is metallically connected by soldering, thus securing an earth connection with the system of mains under the whole city.

Printing by Electricity.—The *Lawrence American*, of July 9th, says:—"For more than ten days past the entire power for running not only the large Hoe press upon which this paper is printed, but for the cylinder and job presses of the entire printing establishment has been from electricity coming over a single wire from the dynamos, four blocks away; the fires under our steam boiler have now slept nearly two weeks, while the little electrical machine, weighing only 800 lbs., quietly, steadily, unceasingly, without jarring or difficulty, keeps up its marvellously equal revolutions. There is no delay in waiting to get up steam, no loss of time from any of the ordinary uncertainty of boilers, but whenever the minute comes when the power is required, a single movement of the lever, and the wheel starts upon its swift unchanging revolutions. We believe the *American* is the first daily newspaper, if not the first regularly published journal of any description, to be printed in this country with electrical power. To what will not this yet but little understood power be turned?"

The American Exhibition, London, 1886.—General C. B. Norton is energetically engaged in making the necessary preparations for the gigantic exhibition of the arts, manufactures, products and resources of the United States which is to be held in London in 1866, and from the influential and substantial support he is receiving it seems probable that we shall witness as complete an exposition of the untiring activity of our American cousins in all branches of art and manufacture as it is possible to have. In the list of promising exhibitors we see no mention of manufacturers of electrical machinery, but doubt not that these will be fully represented, inasmuch as the prospectus, or what appears to serve as such, announces that "the manufacturing department will comprise the development in every branch of that inventive genius which in the United States has reached so high a point, and, so far as possible, it is proposed to present the various processes in working order, by the aid of electricity, steam, gas, or hydraulic power."

International Inventions Exhibition, 1885.—Owing to an unavoidable delay in the circulation of the prospectus of the great exhibition which is to be held at South Kensington next year of inventions patented or brought into use since 1862, the time within which applications from exhibitors in the United Kingdom for space will be received has been extended to October 1st. From foreign countries and the colonies applications may be sent up to November 1st. Foreign and colonial commissioners appointed by their governments are invited to communicate with the secretary, Mr. E. Cunliffe-Owen. Such commissioners will be charged with the consideration of all questions relative to the distribution of the space allotted to their respective countries. They will be required to guarantee that all exhibits in their respective sections are in accordance with the classification and with the regulations.

Applicants for space from countries in which no commissioner has been nominated must appoint agents in England to act on their behalf. Some disappointment may be prevented, and some hopes may be raised, by the early announcement that untried and unpatented inventions will not be accepted unless recommended by a competent authority. The secretary of the Society of Arts, Mr. H. Truman Wood, who sailed from Liverpool last Saturday, in order to take charge, as joint secretary, of affairs in Section G at the British Association meeting, will before his return visit Washington and other cities in the United States, with a view to interest the responsible officials of the Government and the Patent Office, the governing body of the Smithsonian Institute, and leading members of various industries in the purposes of the exhibition.

The British Association Meeting.—The *Times* of Tuesday in an article on the coming meeting of the British Association at Montreal, gave considerable space to suggestions as to the probable tenour of the addresses of the various presidents of sections. Respecting the president of the association, Lord Rayleigh, the writer said—"He is both a man of affairs, a Cambridge professor, and an original worker in some of the most abstruse departments of physics. The branch of science with which he is more particularly connected has the widest and most varied field and the most far-reaching bearings in practice; and, therefore, an account of recent progress in the various departments of physical science, when given with Lord Rayleigh's well-known skill and clearness, would be sure to interest any intelligent audience. Such, therefore, we believe, is likely to be the subject of this year's presidential address. Lord Rayleigh cannot but refer to the serious loss which science has sustained since last meeting in the death of Sir William Siemens, and he may take advantage of the opportunity to say a good word on behalf of inventors. Electricity, especially in some of its practical applications, cannot fail to come under the notice of the president, and he may have some hopeful words to say on the future of electric lighting. Among the names he may have to mention of those who have done important service in the recent progress of electricity as well as other branches of physics, will probably be some whom the United States, at least, if not Canada, can claim as citizens. It is possible, also, that the president may make some reference to the place of science in education, and if so, his opinions are not likely to be very acceptable to the out-and-out adherents of the older leaning. It would be only in accordance with precedent that the relations of science to the intangible and the unseen should be touched upon in the presidential address; but if Lord Rayleigh does so we may be sure it will be in words of tenderness and hope. Such, so far as we can learn, are likely to be some of the topics touched on in the presidential address at Montreal; of one thing we may feel sure that in Lord Rayleigh's hands it will be worthy both of the Association and of the unprecedented occasion."

The Consolidated Telephone Company.—A shareholder in this company writes to a contemporary:—"Towards the end of March, 1883, when the affairs of the company were in a very precarious condition, a circular was issued by the so-called 'Investors' Protection Association,' extolling the position of the Consolidated Telephone Company to the skies, and recommending a purchase of the shares. This circular induced me and others to purchase largely the shares of the Consolidated Telephone Company, and shortly afterwards new shares were issued at a discount. At the time the circular was issued the real condition of the company must have been well known to the writer of the circular, and the object of it was no doubt to raise the price of the shares just before that knowledge became public. The 'Investors' Protection Association' had offices at 68 and 69, Cornhill, and this was the committee of management:—Richard L. Adams, chairman; Timothy Butler, Thos. Whitehead Parker, Charles Clough, Charles Smith, John Hardy, James Simpson. Secretary, Joseph B. Chapman. The association seems now to have disappeared. They extracted a guinea from me for their precious information, and did not send another circular, though they professed to send, I believe, four a year. If any of your readers can give any information respecting the association I should be obliged. I should also be willing to join any others, who were duped as I was, in taking proceedings against the directors."

A Whale's Adventure.—Mr. Robinson Kendal, chairman of the West Coast of America Telegraph Company, relates, as a matter of curiosity and unique experience in connection with the working of submarine telegraph cables, that a whale voluntarily attacked a cable, and, having had a free fight with it, paid for his temerity with his life, being held prisoner for seven days, and then mangled unto death. In its struggles to get free, the cable cut right into its side, the whole of its entrails coming out, and great streams of blood. In its last dying struggle it parted the cable on the bow sheaves and floated to windward of the steamer. The cable was twisted up in the form of a wire rope for about two fathoms, and in six different parts it had the appearance of having been bitten through sufficiently to stop all communication.

Another Electric Launch.—On Monday a trial trip was made from Bolton to Bury on the canal by Mr. W. Banks, of Corporation Street, Bolton, on a new electric launch. The boat, which has been built specially for the purpose, is 21 ft. long by 4 ft. 6 in. beam. The motive power is 20 F.S.V. accumulators (½ H.P. type), actuating a Reckenzaun motor coupled direct to the propeller shaft. The propeller is 12 inches diameter and 11 inches pitch, and makes 456 revolutions per min. This is being replaced by another only 7 inches pitch, when it is expected that the maximum speed of six miles per hour obtained on Monday will be increased to eight miles. Great satisfaction was expressed by J. R. Bridson, Esq. (for whom the launch has been built) and party at the performance of the boat. Its appearance on the canal caused no little curiosity, and various suggestions were made as to the cause of motion, as nothing can be seen standing above the sides of the boat. After a run of three hours (with the exception of a slight heating in the motor) everything was satisfactory. The accumulators are charged by a Lumley dynamo at Mr. Bridson's works, ordinarily employed in supplying current for a number of Swan lamps recently supplied by Mr. Banks. A switch and reversing gear is conveniently at hand, so that the motor and cells are entirely under the control of one man.

"Gülcher" Electric Light and Power Company, Limited and Reduced.—Mr. Thomas H. Harrison informs us that he has been appointed agent to this company, and states that he is prepared to advise as to the most suitable kind of installation of electric light for any particular building, and to furnish estimates for the supply and erection of the same. His address is 5, Lawrence Pountney Lane, Cannon Street, E.C.

Mr. Crosskey applied on Wednesday for the sanction of the Court to the reduction of the capital of the company from £300,000 in £5 shares, to £150,000 in like shares. The matter had in the usual manner been referred to the chief clerk, who had found that some creditors, but not all, consented to the proposed reduction of capital. It now appeared that all the creditors who had not consented before the chief clerk had since either consented or been paid, with the exception of one creditor for £15 8s. 2d., whose debt it was now proposed to pay into Court. His Lordship sanctioned the proposed reduction, and dispensed with the title "and reduced" from the expiration of 14 days after the date of the order.

Electrical Manufactures.—We understand that Messrs. Blakey, Emmott & Co., of the Northern Telegraph Works, Halifax, have recently supplied a number of Fletcher's patent watchman's tell-tales, as described by us in our issue of January 26, to the Government of Victoria, and are now fitting them throughout the extensive works of Messrs. J. Crossley and Sons, Limited, who had one mill fitted as an experiment a few months ago. We may also mention that Messrs. Blakey, Emmott & Co. have secured the London and North Western Railway Company's contract for the supply of telegraph apparatus for this year, and they are now very greatly extending their factory which, when finished (about the end of the year), will, we are informed, be one of the largest and most complete in England.

The Late M. Volckmar.—Probably a large number of our readers will find the following, addressed to the New York *Electrical World*, and signed "Verax," most interesting reading:—"The New York *Herald*, of July 23, published a cable message from Paris respecting the death of Volckmar, in which mention is made of his having started the Faure Accumulator Company. As this is absolutely incorrect, will you allow me, as a friend of Mr. Faure's, to give you a faithful account of Volckmar's connection with the Faure accumulator, which has been incorrectly styled the "Faure-Sellon-Volckmar," more particularly in Europe? Volckmar's history reflects nothing to his credit. In the summer of 1881 he was introduced to Mr. Philippart, the president of La Force et la Lumière, by an American. Volckmar obtained employment in the workshops of the French company. Here he began his scheming. He soon acquired an ascendancy over two of Mr. Philippart's sons, both of whom were holding responsible positions in the company, and by his assiduous efforts he so worked upon their minds that during Mr. Faure's and Mr. Philippart's absence from Paris he attempted to dispose of patent rights, &c., the company's property, and when caught and convicted in the act of treating with parties with whom he had no right to have any dealings he suddenly left Paris, taking with him the younger Philippart, who was at that time under age. He next turns up in London, where he worked in the profoundest secrecy for nearly six months under the auspices of Mr. Sellon, of the Anglo-American Brush Company. Volckmar was not an electrician; he had not been long enough in the French workshops to obtain more than a smattering, so while Volckmar's name was always prominent, the real worker was Gustave Philippart, who was possessed of all the secrets and cognisant of all the experiments made in the workshops by Mr. Faure. The Faure Accumulator Company was formed by Mr. Philippart, senior, acting as President of La Force et la Lumière, early in 1882; during the first few months of its existence it was managed by a board of honourable men. The Electrical Power Storage Company was formed some three or four weeks later than the Faure company. From the very first it was manifest that these two companies must be antagonistic to each other, since the Faure company possessed the real Faure patent, while the other company could merely boast of their title to what they knew to be an infringement of the Faure, which they called the Sellon-Volckmar, but in reality was nothing but Gustave Philippart's reproduction of Faure's latest improvements. Naturally enough Faure commenced suit against Volckmar for infringement, and though many people may have been under the impression that this matter was settled, as a matter of fact it has never been so. Volckmar owes his prominence to a little electrical financing which was exposed at the time in *Truth* (London). Mr. Philippart, having been refused a seat at the board of the Faure Accumulator Company, determined to be revenged. He compromised with Volckmar on a secret deal, obtaining from him a large sum of money, with which he bought up all the unissued stock of the Faure company, and then the control of the issued stock, afterward handing over the rights of the Faure company to the Electrical Power Storage Company, thereby ousting the original shareholders out of their rights, since practically they obtained no consideration whatever for the transfer. Volckmar reached the zenith of his career toward the end of 1882, and it is reported of him that he paid up a vast accumulation of gambling debts in Paris; but his loose habits and swindling methods of business ultimately caused him to fall out with his best friends, Mr. Sellon, *et al*, and caused his dismissal from the company. Since that time he had been hanging about Paris, and as far as I know was much embarrassed in money matters."

Death of Mr. James White, Optician.—Mr. James White, the well-known optician, died last week at Glasgow, at an advanced age. Born in Islay, he went to Glasgow when still a boy, and in 1836 was indentured to Messrs. Gardner and Co., to learn the trade of an optician. About 30 years ago he started business in Renfield Street, along with a Mr. Barr, and on the dissolution of partnership some time after, he opened a shop in Buchanan Street, again removing to the present premises at 209, Sauchiehall Street. He was appointed philosophical instrument maker to the University, and in this capacity carried out many of the inventions of Sir William Thomson, particularly the submarine recording instrument, the mariner's compass, and the navigational sounding machine. His reputation as an optician extended to foreign countries, from which there was great demand for his work.

Suicide of Anthony Arnoux.—The suicide of Anthony Arnoux, which took place in New York, on the 3rd of July, is stated to have been caused by mental depression. He was associated with Mr. Hochhausen, whose experiments with dynamos had been carried on for years before the existence of such a machine was generally known in electrical circles.

NEW COMPANIES REGISTERED.

Evered and Company, Limited.—Capital, £200,000 in £10 shares. Objects: To trade as brass and iron founders and engineers, and as manufacturers of machinery and apparatus connected with electric, gas, or other lighting, or with electric and magnetic force and power in general, or connected with telegraphs or telephones; and for such purposes to take over the business carried on at various places in the United Kingdom by Richard Evered and Company, Limited. Signatories (with one share each): W. B. L. Atkins, 1, Queen Victoria Street; *Richard Evered and *R. B. Evered, of Horley, Surrey; G. J. Evered, Putney; D. Bartlett, 25, Prince of Wales Road, Kentish Town (Secretary); E. Swift, 6, Eastwood Terrace, Hornsey Road; *G. Kent, 199, High Holborn. The signatories denoted by an asterisk, and Messrs. R. W. Hailstone, A. H. Griffiths, and F. A. Wallwroth are the first directors, Messrs. R. B. Evered and A. H. Griffiths being also appointed managing directors for five years. Registered 14th inst. by Messrs. Davidson and Morriss, 40, and 42, Queen Victoria Street.

Eteve Engine Company of America, Limited.—Capital, £160,000 in £50 shares. Objects: To acquire letters patent in connection with motive power, and in the United Kingdom, America and elsewhere, to carry on business as mechanical and chemical engineers, and as workers and dealers in electricity, motive power and light. Signatories: R. Angus, 69, Holland Road, 5 shares; J. Murphy, Highgate, 1 share; E. Bull, Chiswick, 5 shares; R. Radermacher, 16, Golborn Road, W. 10 shares; E. L. Ernest, 8, East Acton Villas, 1 share; E. Moreton, Catford, 1 share; W. Lichfield, Lee, 5 shares. Directing qualification, 50 shares. The signatories are to appoint the first directors. Registered the 20th inst. by E. S. Gover, 10, Walbrook.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Anglo-Spanish (Brush) Electric Light and Power Company, Limited.—The annual return of this company, made up to the 11th ult., was filed on the 14th inst. The nominal capital is £200,000, in £5 shares. The number of shares taken up is 8,907, upon which £3 per share has been called, the calls paid amounting to £26,038 10s., leaving £682 10s. unpaid. As compared with the previous return, the paid-up capital shows an increase of £595. Registered office, 110, Cannon Street.

South Eastern (Brush) Electric Light and Power Company, Limited and Reduced.—The order of the Chancery Division of High Court of Justice, dated 9th inst., sanctioning the reduction of the capital to £51,000, was filed on the 18th inst. The order also directs that the words "and reduced" form part of the name of the company for one month of the date thereof.

Buenos Ayres Electric Light Company, Limited.—The annual return of this company, made up to the 27th May, was filed on the 15th inst. The capital is £100,000, in £10 shares. Seventy shares have been taken up, but no call has as yet been made, although the company was registered in 1881. Registered office, 1, East India Avenue.

CITY NOTES, REPORTS, MEETINGS, &c.

River Plate Telephone and Electric Light Company, Limited.

THE second ordinary general meeting of this company, after repeated postponements, was held on Monday, at the Cannon Street Hotel, Colonel Gouraud presiding.

The report which was submitted to the meeting was published in our columns so long ago as May last. The following was circulated just before the meeting:—

"To the Shareholders,—In view of my resignation from the chairmanship and from the board of this company, as intimated in the notice calling you together on the 18th inst., it may not seem inappropriate to the occasion that I should present to you a brief statement showing the position of the company at the date when I accepted the chairmanship, as compared with its position to-day, when I terminate my official connection with it. I joined the board on the 19th March, 1883. The first returns after that date show the total number of subscribers in Buenos Ayres and Monte Video to have been 1,160, of an annual value of £19,558. There are, by the latest returns, 1,709 subscribers, of an annual value of £26,985. The liabilities of the company on the 19th March, 1883, were something over £15,000, almost exclusively due to the Consolidated Company. This amount has since been increased to something over £26,000. This entire indebtedness will have been liquidated when you shall have confirmed the settlement made by the directors, which has already received the sanction of the Consolidated Company, and which will place this company in an obviously strong and satisfactory position. Up to the time of my joining the board no dividend had ever been paid. The dividend now recommended is the second since then. You will thus have received 9 per cent. per annum upon your entire investment from its commencement down to the end of the last financial year, besides having written off over £3,000, and carried forward the substantial balance of over £5,000. The present income of the company is more than sufficient to meet the 9 per cent. dividend upon the entire amount of preference shares and debentures of the company. With judicious management in the future, you should continue to receive regular and increasing dividends. In reply to the several enquiries as to the reasons which have led me to resign, and Mr. Carnegy and Mr. Spensley not to offer themselves for re-election, I have to say that they are purely personal, and have obviously nothing whatever to do with the present financial position of the company, which is highly satisfactory, or with its prospects. In conclusion, I take this opportunity of recording the very great obligations of the company, as well as of myself, to my colleagues, for the earnest and able co-operation which I have uniformly received at their hands throughout my chairmanship. "G. E. GOURAUD,

"Chairman of the River Plate Telephone and Electric Light Co., Limited."

The Chairman now said the delay was occasioned by the raising of the question by the shareholders of the Consolidated Telephone Company as to whether their directors were empowered to make the settlement which had been agreed upon by the two boards in regard to the debt owed by the River Plate Company to the Consolidated Company. But for this the shareholders of this company would have received their dividend, recommended in the report, some months ago. With regard to the report he had very little to volunteer; he thought it represented the company to be in a very admirable position. They had a handsome balance carried forward, after paying the 9 per cent. dividend, which, with the dividend already paid last year, would make a 9 per cent. accumulative dividend upon their investments. He moved "That the report of the company's working for the year ending 31st January last be adopted."

Mr. P. Carnegy seconded, and the motion was carried.

The Chairman then moved: "That a dividend at the rate of 9 per cent. per annum, from dates of respective payments, to the 31st January, 1884, including the interim dividend on 1st August, 1883, be and is hereby declared."

Sir Alexander Armstrong seconded.

Mr. Fitzgerald said he should like to make a remark respecting that dividend. It appeared to him that with the debt of £20,000 owing to the Consolidated Company, as it was at that time, the dividend should never have been paid. The dividend might be said to have been fairly earned, but it should have been explained to the shareholders that they were at that time indebted to the Consolidated Company to the amount he had mentioned. He saw that Colonel Gouraud stated, in a memorandum he had circulated, that the returns of subscribers in Buenos Ayres and Monte Video were, at the time he joined the board, 1,160, and the annual value £19,558, and that these figures had increased, up to the latest returns, to 1,709 subscribers and £26,985 annual value. Surely Col. Gouraud did not take credit for having got the subscribers; the credit, he should think, was due to the board at Buenos Ayres. They knew about the indebtedness of the company. The Consolidated Company (of which he was chairman) sold them instruments for erection in Buenos Ayres, to enable them to earn the income which they were now earning. He certainly endorsed all that was said by the chairman as to the favourable position of the company. The company was doing well, and the dividend was certainly earned, and could he have possibly done so he would have paid it some months ago. They probably knew the reasons why the retiring directors did not offer themselves for re-election, and why Col. Gouraud resigned, and it was not worth while to further allude to it.

The Chairman said, with regard to Mr. Fitzgerald's remarks, he should be paying a very poor compliment to their intelligence if he thought they had not remarked that, in the same breath, he criticised the payment of the interim dividend, telling them it ought not to have been paid, and, by way of showing his importance to them, then stated that if he had been able to do so he would have paid this later dividend in May. At the same time, he said the interim dividend was paid when the shareholders did not know of the liability to the Consolidated Company. That dividend was paid almost immediately after the report, which was in all their hands. At the meeting held about that time, several of the shareholders expressed their opinion that a dividend should be paid, saying it was usual for other boards to pay a dividend when it was being earned. It must have appeared to them that Mr. Fitzgerald went a long way out of his way to make an insinuation regarding himself (Col. Gouraud). This did not surprise him, for Mr. Fitzgerald had an unhappy weakness in that direction. It might be a matter of surprise to many that, after having carried the company through difficulties that he could give them no idea of, to so successful an issue as the present position of the company, they should voluntarily relinquish their positions as chairman and directors. He was a shareholder in the company, like themselves, and he had been anxious to hand this splendid property over to his successors without blemish. For that reason, and thinking it possible that the state of his throat would prevent his speaking to them, he issued the circular which they had seen, in which he stated that the reasons which actuated them in retiring were purely personal ones. He would have been glad to have left the matter there, but Mr. Fitzgerald, in the exercise of his greater wisdom, had thought it necessary to make insinuations, to which he felt bound to reply. Therefore, he would tell them exactly what Mr. Fitzgerald meant to say. He meant to tell them that there was on the board of the Consolidated Company a personal bitterness of feeling towards himself (Col. Gouraud) and his colleagues, which surpassed Mr. Fitzgerald's powers of description, and that was saying a great deal. The Consolidated Company was the principal shareholder of the River Plate Company, and but for its support they would not have been able to meet the enormous demands for the extension of their system in Buenos Ayres and Monte Video. The Consolidated Company held such a controlling interest, that they could eject directors if they wished to do so. That, however, was not the case. As an actual fact, the Consolidated Company did not now hold a majority of shares in this company, therefore it was not possible that they could do exactly as they wished. But Mr. Fitzgerald would have tried. He would have called an extraordinary general meeting for the purpose of putting them out. It would depend, then, upon whether he could control three-fourths of the shares. He (the chairman) had too much confidence in the sense of fair play belonging to the majority of Englishmen—in which respect, however, Mr. Fitzgerald had distinguished himself as an exception—to believe that he would succeed. But the holding of extraordinary meetings, and the necessary concomitants, would have acted very prejudicially upon their property, and he thought it wiser to withdraw from the board. With respect to his insinuation that he (the chairman) had taken the credit for the increased prosperity of the company, they would see by the report that it was distinctly stated that the board felt that they were in no small degree indebted for that result to the able and energetic management of Mr. E. F. Powers, their managing director in the River

Plate. In reply to a shareholder, the chairman said it was probable that presently the board of the Consolidated Company would offer to their shareholders shares in the River Plate Company, which they had purchased, and that it was quite possible that they might offer them to shareholders in this company as well.

Mr. Fitzgerald said they would only be too glad to offer shareholders in the River Plate Company some of the shares they held. So far from his company desiring to have control of the River Plate Company, they would much prefer the money.

The motion approving the dividends was then put and carried.

The Chairman moved the election of Mr. John Taylor as a director in the place of the Hon. H. Spensley.

Mr. Fitzgerald seconded, and the motion was unanimously carried.

Several shareholders expressed their regret that Col. Gouraud and the other directors thought it necessary to withdraw from the board, and suggested that they might reconsider their decision.

The Chairman, however, said they could not do so, as they were persuaded that it was the better course to adopt, not to offer themselves for re-election. He then moved the election of Major Henry Thomas G. Fitzgerald in the place of Mr. P. Carnegy.

Mr. Fitzgerald seconded this also, and it was carried.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., having been re-elected,

Mr. Fitzgerald rose and said that Sir Julius Vogel was a director of the company, but he was at present on leave of absence, and was not likely to return for some time. He was entitled to his salary, notwithstanding that he did not attend the meetings of the board.

The Chairman said this was a question which it would be no advantage to discuss. Sir Julius Vogel was an original director, and this company, he believed, was his own individual conception. He was absent undoubtedly, and probably indefinitely so, but under the articles of association he was entitled to his salary. As he (the chairman) had little doubt that it was Mr. Fitzgerald's intention to throw mud at Sir Julius Vogel, he felt bound to stand up and do what he could to prevent it. He would put it to the meeting whether Mr. Fitzgerald should be heard further on the subject.

The majority having voted in the negative,

Mr. Fitzgerald said, that being the case, he would propose a resolution—"That in consequence of the continued absence of Sir Julius Vogel from England, and its probable duration, the resolution giving him leave of absence be rescinded as from this date; and that he be removed from the board in accordance with article 103."

A Shareholder seconded this motion, but

The Chairman said it was entirely out of order. Such a motion could only be put at an extraordinary meeting, and after notice had been given.

Mr. Fitzgerald: I take it that the shareholders do not want to go on paying Sir Julius Vogel a salary for doing nothing.

The Chairman said he could not permit any further discussion on the subject.

The meeting was then made an extraordinary general meeting to consider the terms of settlement of the debt of £28,000 owing to the Consolidated Company.

The Chairman said the terms proposed, which had been agreed upon by the two boards, consisted of an award to the Consolidated Company of £20,000 nominal debentures having five years to run and bearing 9 per cent., the remaing £8,000 to be handed over in shares to the Consolidated Company. He moved: "That the action of the board in reference to this settlement is hereby approved, and the directors are hereby authorised to take the necessary steps to carry the same into effect."

Mr. Clarke seconded this motion, which was carried unanimously.

The Chairman then remarked that the business in the River Plate had been entirely created by the energy of Mr. E. F. Powers. He did not know what changes the new directorate would think fit to institute, but Mr. Powers was a nephew of his (Col. Gouraud's), and that was a great disadvantage to him. [Several shareholders: "No, no!" Mr. Fitzgerald: "Certainly not."] Well, he hoped it was not, and that he would be allowed to remain. He had no desire to remain, but had promised at his (Col. Gouraud's) desire to remain in the River Plate two years more at least.

A vote of thanks to Col. Gouraud and the retiring directors was proposed, and regret again expressed that it was necessary for them to resign. The vote was accorded unanimously, and the meeting terminated.

Pilsen-Joel and General Electric Light Company, Limited and Reduced.

THE report of the directors, to be presented at the third ordinary general meeting, to be held next Thursday, has been issued, and is as follows:—In enclosing the accompanying notice of the third ordinary general meeting of the above company, the directors are glad to inform the shareholders that they have successfully carried out the first special resolution passed at the general meetings held in March last, and they congratulate them on the fact that the 11,530 fully-paid shares owned by the Union Company, and 370 out of the 470 held by other parties, are now surrendered, leaving only 100 fully-paid shares on the register. This relieves the company from a heavy liability, and is practically a large reduction, amounting to 60 per cent., off the price originally paid for the patents.

The second special resolution, viz., to reduce the liability on the partly-paid shares by £1, is being carried out as rapidly as the legal formalities will admit, and the directors hope that the necessary Order in Court may be speedily obtained; but they would point out to the shareholders that by the purchase and extinction of the fully-paid shares the importance of the second resolution is much diminished, as these fully-paid shares constituted the only liability beyond the control of the company, and they no longer exist.

The position of affairs at the close of the second year of operations as shown by the accompanying balance-sheet, is very different from what was generally anticipated at the company's formation. The chief cause of this result is, in the opinion of the directors, the serious discouragement given to electric lighting companies by the Electric Lighting Act of 1882, which, by the onerous conditions it imposed on the suppliers of electricity, and the inducement it offered to the consumers to wait for better terms, so checked and stifled the demand both for public and private lighting, as practically to destroy the prospects with which this and other companies were formed in 1881-2. To this must also be added the general commercial depression, and the consequent absence of all speculative investments, which have existed since that period.

The directors still believe that the lamps for which the company hold patents are unsurpassed in the market, and that in the event of any revival in electric lighting generally, their superior qualities would be manifested. They believe further, that although electric lighting may have been successful in other countries, where it has not been interfered with by the Government, no company has fared better in this country than ourselves.

Nevertheless it is necessary to face our present position. A choice of courses appears open, without adopting any extreme measure, such as has been mischievously suggested to the shareholders, which would certainly involve an absolute sacrifice of the property of the company.

The directors assume that the shareholders generally are of the same opinion as themselves that, under present circumstances, and under any that are likely to arise within a reasonable period, it is not expedient to incur the risk of being obliged to make a further call on account of unpaid capital.

Two courses are now open to the company:—

1st. To continue pushing the business with as low an expenditure as possible, in the hope of the present depression coming to an early end, and of obtaining an improved business hereafter.

2nd. To give up the prospect—for a time at least—of continuing business as a manufacturing company, and to reduce the expenditure to the lowest point by—*a*. Closing the factory and surrendering the lease, or getting rid of it as soon as possible. The lease will expire in June, 1885. *b*. Closing the city offices, and terminating all engagements with the present staff. *c*. Arranging for the maintenance of the few installations for which the company is under contract in the most economical manner, either by transferring it to other parties who may be willing to undertake it on reasonable terms, or by utilising the factory for that purpose exclusively while it remains on our hands, and—*d*. Disposing of the plant, stock, and material of the company *en bloc*, or in detail, with or without the patent rights, as purchasers can be found.

It may be desirable to reserve the patents for a more favourable season, as they are undoubtedly of considerable value, and sooner or later electric lighting must win its way; and it may be possible to arrange with other parties for manufacturing and carrying on the business of the company, with profit to the shareholders, under a royalty or other terms, until better times.

The directors wish to point out that, with the exception of the factory sub-committee, who draw £300 a-year between them, they have been working without remuneration since March, 1883, having, as the accounts show, voluntarily relinquished their fees immediately they saw that the company could not afford to pay them; they are very largely interested as shareholders, to the extent of one-eighth of the present capital: they have been as anxious for the success of the company, and are as much disappointed at the results, as the rest of the shareholders.

There can be no doubt that it was intended by the change in the 81st article of the association at the first general meeting, to limit the tenure of office by the first directors to the present year, but by an oversight in not altering the 89th article also, their period of service will not expire before 1886. Under these circumstances, the directors having given the shareholders their opinion and their best advice, desire to leave the decision in their hands, and with this view they now tender their resignation, with the exception of Mr. Fellows, who dissents from this course. They further advise that a smaller and more compact board be elected, which should contain one or two large shareholders.

Economic Electric Company, Limited.

MR. STEPHEN H. EMMENS, the managing-director of the above company, has recently been engaged in frequently addressing circulars to the shareholders, urging them to a show of greater interest in the company, and other things. Finding not sufficient notice, according to his view, has been taken of these, he now announces his intention of resigning, and the following is his latest emanation:—

"Sir,—As you are interested in this company, I think it right to inform you that I have resigned its managing directorship, though I still remain a member of the board. I should long ago have relinquished an office which involved so much arduous (and unremunerated) work, and the constant advance of money which I could ill spare; but I clung to the hope that the constituents of

the company would at length co-operate with the board in making the business successful. As, however, with a very few exceptions, the debenture-holders decline to attend the meetings to which they are summoned, or to answer the circulars sent to them, I cannot any longer consent to sacrifice myself for the sake of people so indifferent to their own welfare. As I shall never address you again, you may perhaps expect me on this occasion to express my opinion respecting the position and prospects of the business. This opinion may be briefly summarised as follows:—

"1. I am confident that had the working capital resolved upon at the March meeting been fully subscribed, you would all ere this have received a first dividend from *bonâ fide* trade profits.

"2. I am equally confident that if you even now provide the working balance of such working capital the business will become self-supporting in future, and will very quickly repay you all you have invested from first to last with substantial profits.

"3. I consider that a subscription of, say, 250 debentures of £10 each, will be amply sufficient for all purposes, even if such debentures be issued at the price of £8 each, payable by instalments, as set forth in the accompanying form.

"4. If such debentures be subscribed you may all expect a dividend for the six months ending December 31st next.

"5. If you do not subscribe the required working capital, I do not see how the board can possibly continue the business; and in that case I think it will be just and fair to apply the whole of the company's assets in discharging its trade debts and paying off recent advances. The business can then be recommended as a distinct enterprise by those of us who may care to co-operate, and every one else will cease to be interested in it.

"I do not go into details respecting the nature of the business, as full explanations have already been given in the various reports and circulars issued from time to time. I will merely mention that we have just opened up a new field for the use of our primary batteries by successfully fitting a tricycle with an electro-motor. This one fact alone is quite sufficient to justify the opinion I have expressed above as to dividends."

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th August, are £2,345 as compared with £1,968 in the corresponding period of 1883. The May receipts, estimated at £6,164, realised £6,296.

NEW PATENTS—1884.

11244. "Dynamo-electric machines." G. FORBES. Dated August 13.

11267. "Separating copper, nickel and cobalt from each other, and from other metals, by electricity, and in utilising residual products obtained in the said separation." H. H. A. and W. W. WIGGIN, A. S. JOHNSTONE. Dated August 14.

11269. "Motive power for driving dynamo-electric machines for the purposes of electric lighting." B. P. STOCKMAN. Dated August 14.

11296. "Contact rollers, or roller brushes for dynamo and magneto electric machines." G. HOOKHAM. Dated August 15.

11307 "Electric telephony." J. G. LORRAIN. Dated August 15.

11322. "Producing vegetable carbon for electrical purposes." A. F. WESTERLUND. Dated August 15. (*Complete.*)

11323. "Telephones." W. E. IRISH. Dated August 15.

11324. "Telephone transmitters, or circuit interrupters, for transmitting articulated speech and other sounds." W. E. IRISH. Dated August 15.

11325. "An improved system or method and means to be used in connection therewith of receiving and automatically recording articulated speech and other sounds transmitted telegraphically, telephonically, or otherwise, by the aid of electricity." W. E. IRISH. Dated August 15.

11339. "Burglar and fire alarm apparatus." T. WRIGHT. Dated August 16.

11351. "Uniting metals, alloys, &c., by electricity." W. B. BRAIN. Dated August 16.

11360. "Galvanic batteries." J. W. ROGERS, G. K. COOKE. Dated August 16.

11362. "Producing materials for insulating purposes." A. PARKES. Dated July 11.

11363. "Telephones." A. J. BOULT. (Communicated by S. de Kraft.) Dated August 16.

11385. "Construction of coils or apparatus for the production and passage of currents of electricity." L. GAULARD, J. D. GIBBS. Dated August 18.

11393. "Construction of armatures for dynamo-electric machines." R. P. SELLON, J. S. SELLON. Dated August 18.

11413. "Electric generators." W. P. THOMPSON. (Communicated by T. Elcoate.) Dated August 19.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

5978. "Manufacture of carbons for incandescent electric lamps." J. W. SWAN. Dated December 31. 6d. The inventor takes a carbonisable material in a plastic or semi-liquid state, and squeezes or presses it through a hole or die so as to form a thread or threads of equal substance and of any required length, and also of any required form in transverse section. The material employed in carrying out the invention is a solution of nitrocellulose in acetic acid, with or without the addition of other well known solvents of nitrocellulose, and with or without other carbonisable material than nitrocellulose. The process of forming carbonisable thread by squeezing a carbon liquid or paste through a die is applicable to any suitable carbonisable material in a plastic, liquid, or semi-liquid condition; for example, nitro-glucose, rendered plastic by heat, may be employed. In employing an acetic acid solution of nitrocellulose, the inventor projects the filament as it issues from the die into water or other liquid, which has the effect of instantly setting or giving coherence to the issuing thread. When the thread has been formed in the manner described, it is treated with a solution of hydro-sulphate of ammonia or other equivalent deoxidising agent until it is no longer in a condition to burn explosively, and it is then dried and shaped into the forms in which it is to be used in the lamps, and it is then carbonised in any suitable manner.

5790. "Electrical conductors, &c." H. H. LAKE. (Communicated from abroad by C. H. Goebel and G. W. Bratton, both of America.) Dated December 18. 8d. According to one part of the said invention, the inventor provides a conduit having three tubes, the first tube forms a curb of a street or roadway, the second tube a gutter, and the third tube a portion of the street adjacent to the gutter. Each of the said tubes is disconnected from the other so that the conduit may be readily laid and either tube removed and replaced, without disturbing the remaining tubes. Each tube has a lid or cover, so that access is readily had to the interior thereof for the purpose of laying, repairing, inspecting, testing, and removing the wires. On the sides of the tubes are hooks which are cast with, or secured to, the said tubes and support the electric wires or cables. The first tube is in cross section of the form of a right-angled triangle, the base being above and the perpendicular on the outside or curb line, so that as the hypothenuse comes next to the ground the tube acts as a wedge which, when driven into position, tightens the tubes one against the other and compresses the earth of the side walk, thus producing a firm and compact support for the said tube. The third tube may also be wedge-shaped, so as to compress the earth of the street. The wires are enclosed in articulated blocks of vulcanite, hard India rubber, celluloid, porcelain, concrete or other suitable material, which may be moulded or otherwise produced, the said blocks being strung on the wires and closely connected so as to fully cover, and reliably protect, the said wires and form cables. For the purpose of splicing the wires the inventor employs sleeves, which are fitted within the said blocks and internally threaded for engagement with the threaded ends of the wire. The sleeves being connected with the block serve to hold the blocks one against the other or tighten the series, and are also employed where the direction of the line is changed, or at bends. The blocks may be of the form of balls and sockets to provide a flexible cable, and a similar result is produced by making the contiguous ends of the blocks respectively convex and concave.

5813. "Heating steam generators by means of electric currents." F. C. GLASER. (Communicated by H. Hempel, of Saxony). Dated December 19. 6d. This invention has for its object to effect the heating of steam generators and in particular the boilers of locomotive engines, entirely by electricity. The necessary current in such last-named application being produced by driving the armature of a dynamo-electric machine or current generator on the engine, tender, or carriages from one of the axles thereof. The current so produced is utilised partly directly in heating the boiler and partly for charging accumulators by means of which the quantity of steam to be generated can be regulated at will. ! ! ! (*Provisional only.*)

1884.

6013. "An improved mode of and apparatus for working the call signals in telephonic communication, permitting of a direct call between the subscribers." C. D. ABEL. (Communicated from abroad by La Société Générale des Téléphones, of Paris.) Dated April 5. 8d. Has for its object to permit two subscribers of a telephonic exchange, after their wires have been put in communication through one or more central stations, to signal to each other by a bell by means of a special key, without requiring for this purpose to actuate the signals of the central station or stations, hence the term "direct" has been given to this system. On the other hand, a subscriber can, by means of another key, call the central station without acting upon the signal bell of the subscriber with whom he has been put in communication. For carrying out this double system of signalling each subscriber is provided with two keys, whereby the current of the signalling battery can be sent into the line wire in two different ways, enabling him either to actuate the call signals of the central offices or the signal bell of another subscriber.

CORRESPONDENCE.

Secondary Generators.

The accompanying correspondence may, we think, be interesting to your readers.

To avoid possible misconception it may be better to state, in reference to the last paragraph but one of Mr. Gordon's letter, that this company have not yet concluded finally with the Metropolitan Railway Company, but I hope a contract will be passed shortly.

J. E. Pickering,

Secretary of the National Company for the distribution of Electricity by Secondary Generators, Limited.

August 13th, 1884.

[COPY.]

The National Company for the distribution of Electricity by Secondary Generators, Limited,
18, Warwick Street, Regent Street, London, W.
8th August, 1884.

To J. E. H. GORDON, Esq., B.A., M.S.T.E., *Manager of the electric light department of the Telegraph Construction and Maintenance Company, Limited*, 38, Old Broad Street, E.C.

DEAR SIR,—In your interesting work entitled "A Practical Treatise on Electric Lighting" you are good enough to devote a chapter to our system of electrical distribution by secondary generators.

We are much indebted to you for the very comprehensive manner in which you have treated the question, and we feel sure that you will pardon us for drawing attention to some points which we think you will see, upon reflection, require further explanation in order to do justice to the subject.

A portion of the remarks we propose to offer are necessitated by circumstances which have arisen since the publication of your book.

1. On page 185 you say: "The Gaulard-Gibbs apparatus consists essentially of an induction coil of which the primary coil consists of a long thin wire, and the secondary of a short thick one."

This description does not apply to either the form we had in use at the time your book was written, or to the improved form which we now employ. In both forms the same length and cross section of copper are employed for the two conductors, and in the present form these conductors are absolutely identical in all respects and similarly situated relatively to the iron core. We have adopted this latter design after a long series of experiments.

In effect, the apparatus employed on the Metropolitan railway was composed of columns formed of a cable rolled in two superposed layers of spirals round a cylinder containing iron wires, the cable being formed as follows:

An insulated copper wire of 4 millimetres in diameter (No. 8 B.W.G.), through which the primary current passed, was surrounded, parallel to its axis, by 48 wires (No. 26 B.W.G.) individually insulated, and constituting the induced circuit. Thus the sum of the sections of the secondary circuit was obviously equal to the section of the inductor, and it followed from the central position of the inductor that the mean distance of the two circuits from the central core was the same.

The type of secondary generator now adopted is composed of copper wires of ½-millimetre in thickness, furnished with ear pieces allowing of their being connected so as to form two independent circuits insulated from one another by means of discs of paraffined cardboard. This apparatus, simple in construction and far less costly than the original model, gives even a higher percentage of effective work, and cannot in any way be said to resemble an ordinary induction coil.

2. On page 187 you say: "In order that the plant which we can now afford may be able to supply the required quantity of electricity, the efficiency of the induction coils must not be less than $E_P = 100 \frac{13{,}000}{14{,}500} = 89$ per cent. I fear that it is not likely that the efficiency will be anything like so high as this."

As a matter of fact Dr. Hopkinson, after the most careful tests, found the efficiency of our secondary generators to be, singularly enough, precisely what you had considered necessary, viz., 89 per cent., as per his report dated 14th of March last, a copy of which we have the pleasure to hand you herewith.

3. On the same page (187) you make a comparative estimate between the ordinary 100-volt system and a system where the E.M.F. could be increased to 1,000 volts. You admit that the copper in the latter case (our own) would cost £500 only as against £5,000 in the former, but you add £4,000 in the case of employing a current of 1,000 volts for "Insulator" as against £2,000 under the 100-volt system. Now, in fact, on the Metropolitan railway we had a current of nearly 2,000 volts passing over a primary conducting wire 4 millimetres in diameter (7·16 B.W.G.) and 15 miles in length. The paraffined tape (used for giving partial insulation to the primary conducting wire), when once saturated by the humidity in the tunnels, furnished no insulation whatever, yet the naked primary circuit at the terminals of our secondary generators could be touched without any perceptible derivation.

This installation on the Metropolitan railway worked without a hitch from dusk till 1 a.m. during five winter months to the entire satisfaction of the company, and we are now treating for the lighting of their entire system from a central station at Neasden over a circuit 30 miles long, the total electrical energy to be distributed being equal to 200 H.P.

4. On page 188 you justly remark that: "In very scattered districts (as for instance, the stations on the Metropolitan railway which are now being lighted on this system as an experiment), the proportion of the cost of the copper to that of the rest of the plant in a 100-volt system might be much greater than in the typical case which we have suggested, and in such a case the system might be useful."

We would venture to add, that in such a case the cost of copper in a 100-volt system would be absolutely prohibitive, and we take this opportunity of stating, as we mentioned to you recently at a personal interview, that we do not wish to compete where other systems can be employed, but that our special province is to aid all and commence where previously known systems cease to be operative. In doing so we offer the additional advantage of being able to furnish currents of varying potential, thereby enabling consumers to employ any type of lamp, whether incandescent or arc as well as motive power.

We propose publishing this letter, to which course, as affording us an opportunity of correcting errors, we presume you will have no objection. We are, Sir, your obedient servants,

(*Signed*) LUCIEN GAULARD, (per J. D. G.)
J. DIXON GIBBS.

[COPY.]

[(Electric Light Department),
Telegraph Construction and Maintenance Company, Limited,
East Greenwich, S.E.
August 11th, 1884.

The National Company for the Distribution of Electricity.

DEAR SIRS,—I thank you for your letter of August 8th, and am much interested in what you tell me as to the improvements that you have recently made in your generators.

Whenever I commence to prepare a second edition of my book I shall not fail to write to you and request you to give me full particulars of all improvements that you have made up to that date.

I should, both as a scientific man and as a manufacturer of alternating current machines, be much pleased to see your system successfully tried on a large scale.

I hope that the lighting which you tell me you are about to carry out from Neasden may be complete in time for me to give an account of it in the next edition of my book. (The first edition is about half sold.)

I shall, of course, have no objection to your publishing your letter to me and this reply.

I remain, dear sir, yours faithfully,
(*Signed*) J. E. H. GORDON.

[We shall be pleased if Messrs. Gaulard and Gibbs are successful in their operations on the Metropolitan Railway, but we do not think they have shown themselves wise in again drawing attention to Dr. Hopkinson's report, which has been shown to be quite incorrect. Mr. Gordon doubtless knows exactly what value should be attached to this report.—EDS. ELEC. REV.]

Conductivity of Wires.

Will you please state the *conductivity* per cent. of a copper wire of 078″ diameter, weighing 97 lbs. per mile, having an electrical resistance (at 60° F.) per mile of 9·378 ohms, and by what process of calculation you arrive at the conductivity per cent. ?

Richard Lagerwall.

London, *August 14th*.

[The resistance of l feet of pure copper wire d mils. in diameter, is given by the formula

$$\frac{l \times 10{\cdot}656}{d^2 k}$$

where k is a coefficient dependent upon the temperature of the wire (see "Kempe's Handbook of Electrical Testing, 3rd edition, page 369).

According to this formula the resistance of a pure copper wire one mile (5,280 feet) long and ·078″ (78 mils.) diameter at 60° F. ($k = 1{\cdot}0323$), would be

$$\frac{5280 \times 10{\cdot}656}{78 \times 78 \times 1{\cdot}0323} = 8{\cdot}959 \text{ ohms};$$

the conductivity per cent. (x) of the wire in question would be given by the proportion

$$9{\cdot}378 : 8{\cdot}959 : : 100 : x$$

or

$$x = \frac{8{\cdot}959 \times 100}{9{\cdot}378} = 95{\cdot}5.$$

That is to say, the wire has a conductivity of 95·5 per cent. of that of pure copper.—EDS. ELEC. REV.]